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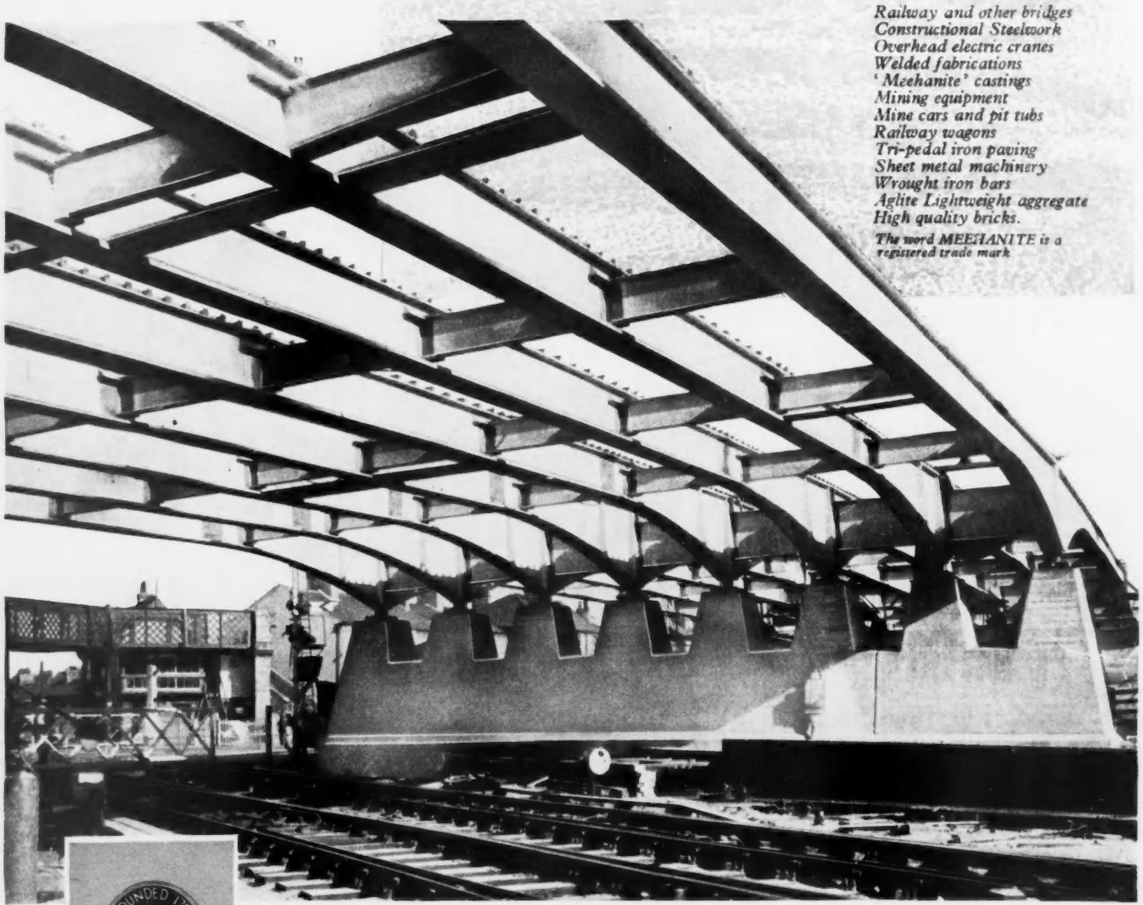

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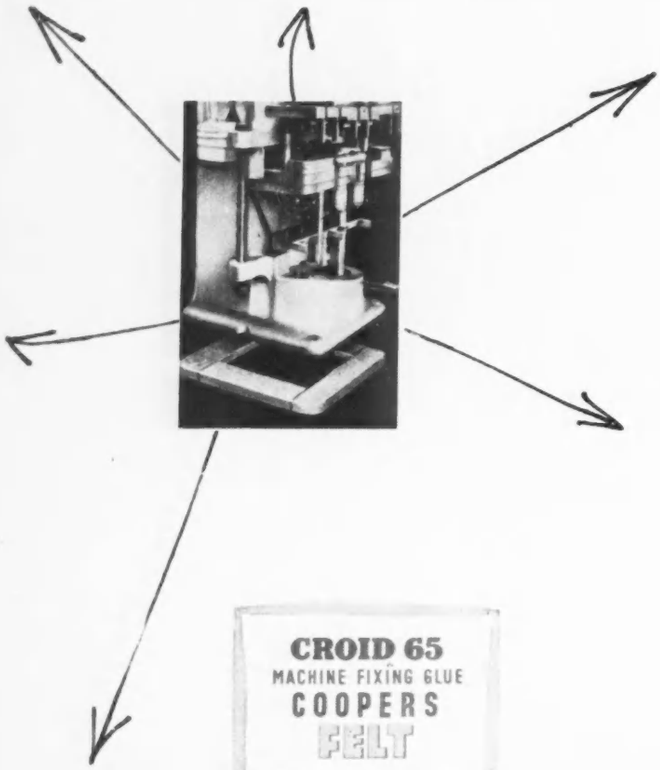

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THE ENGINEER

Established 1856

No. 5360 **OCTOBER 17, 1958** VOL. 206

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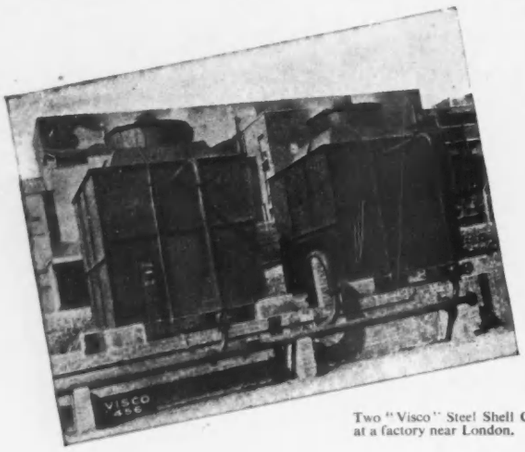

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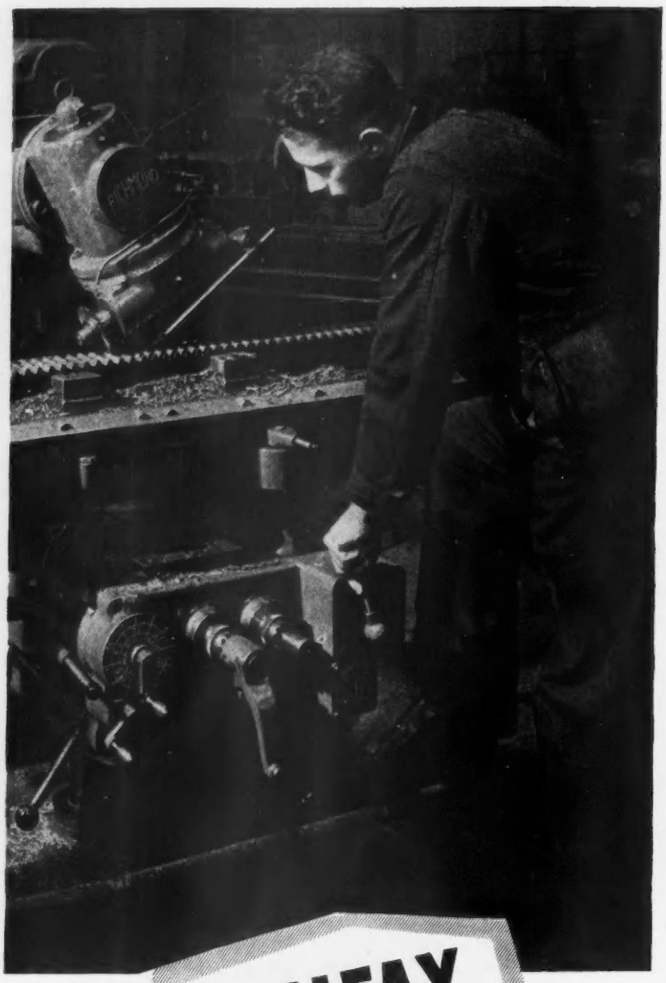

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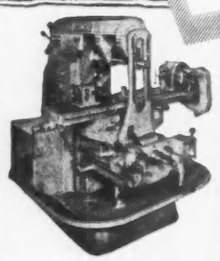

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The photograph shows a Richmond No. 4 Universal Milling Machine fitted with Universal Milling head in use at the Halifax Tool Co. Ltd. This machine is all-geared for high speed work to critical limits.

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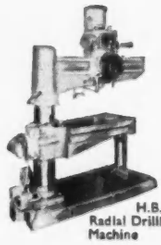

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BK 24B	1200	140	Clamp on
BK 34	2400	355	—
BK 34A	2400	355	Integral
BK 34B	2400	355	Clamp on
BK 42	600	56	—
BK 42A	600	56	Integral
BK 42B	600	56	Clamp on
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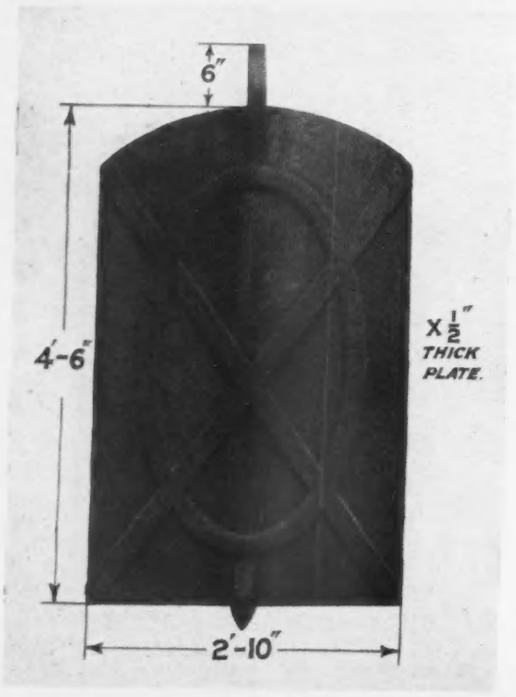

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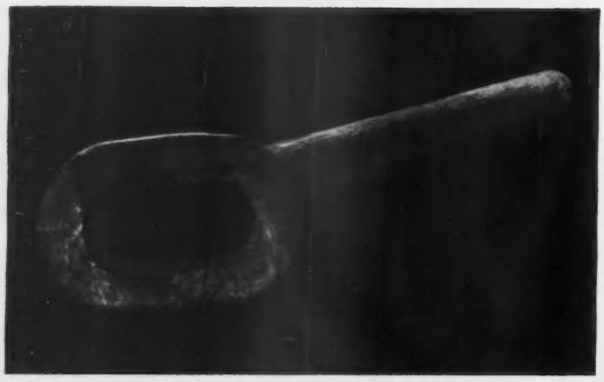

Upper illustration shows a MAXHETE Damper Plate; lower illustration a MAXHETE Feed Pipe casting, 7 ft. long by 7½ in. dia.

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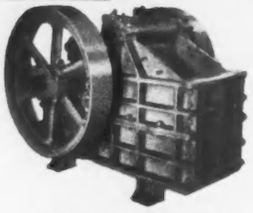

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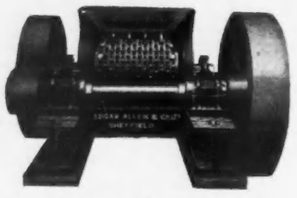

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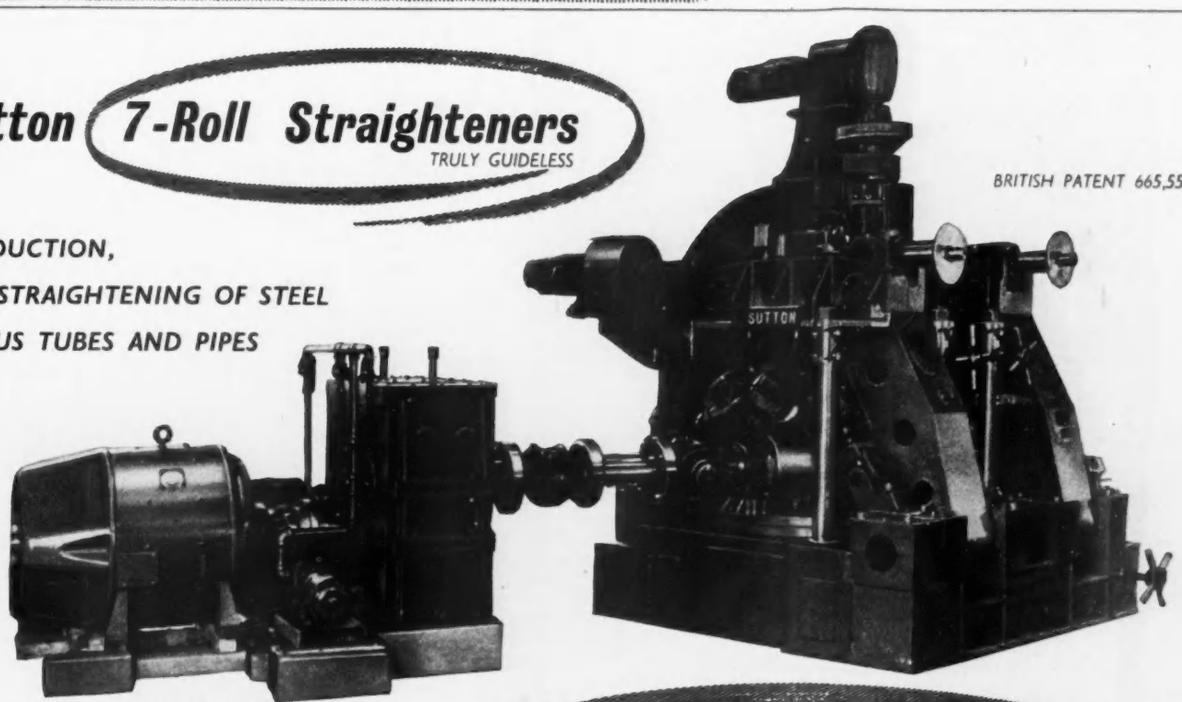

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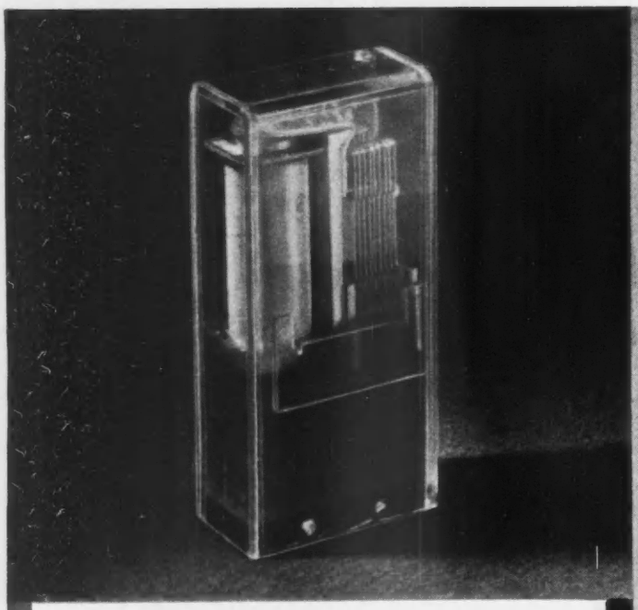

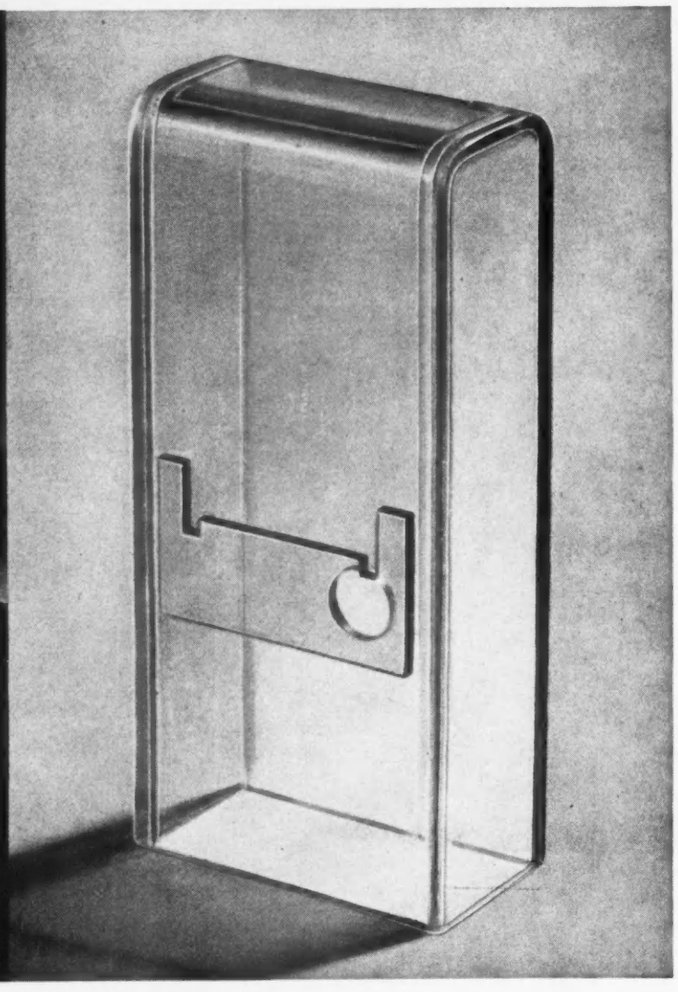

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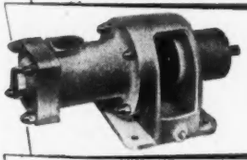

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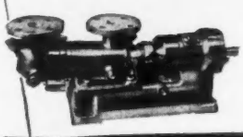

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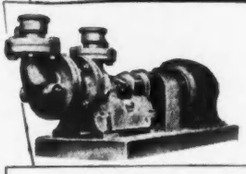

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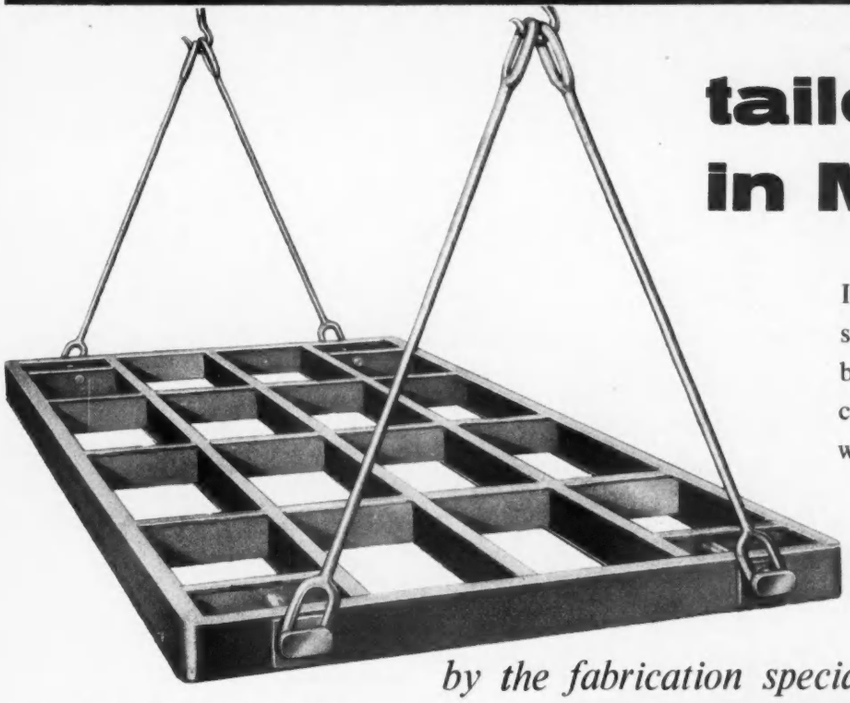

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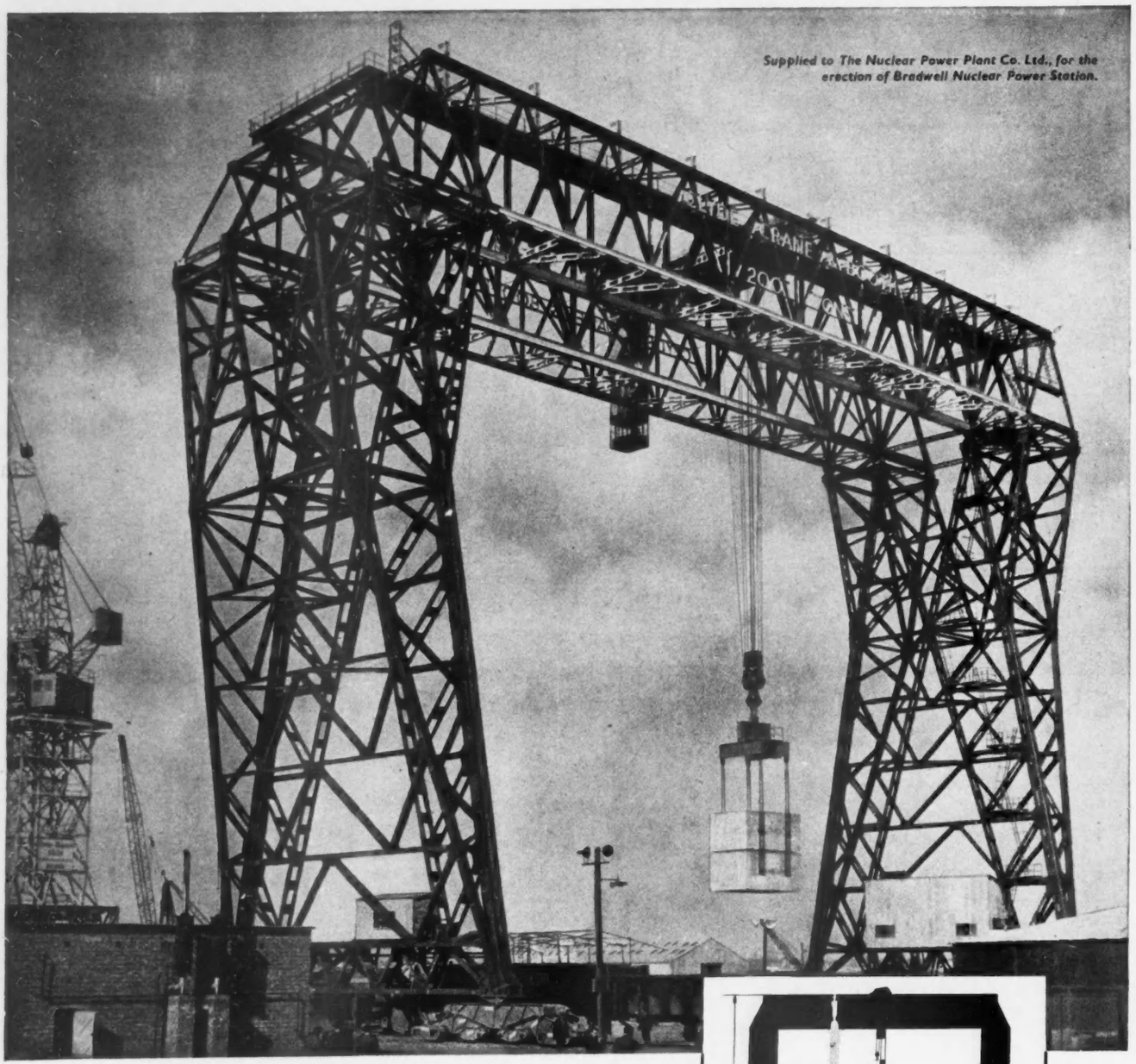
CLYDE-BOOTH 200 TONS GOLIATH AT *BRADWELL NUCLEAR POWER STATION*



Supplied to The Nuclear Power Plant Co. Ltd., for the erection of Bradwell Nuclear Power Station.

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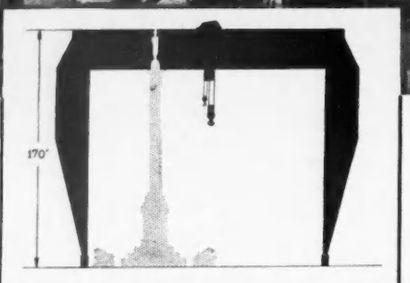

The Booth Goliath showing Nelsons Column on the same scale. Clearance from rail level to underside of bridge is 140'. Distance between rail centres 178'.

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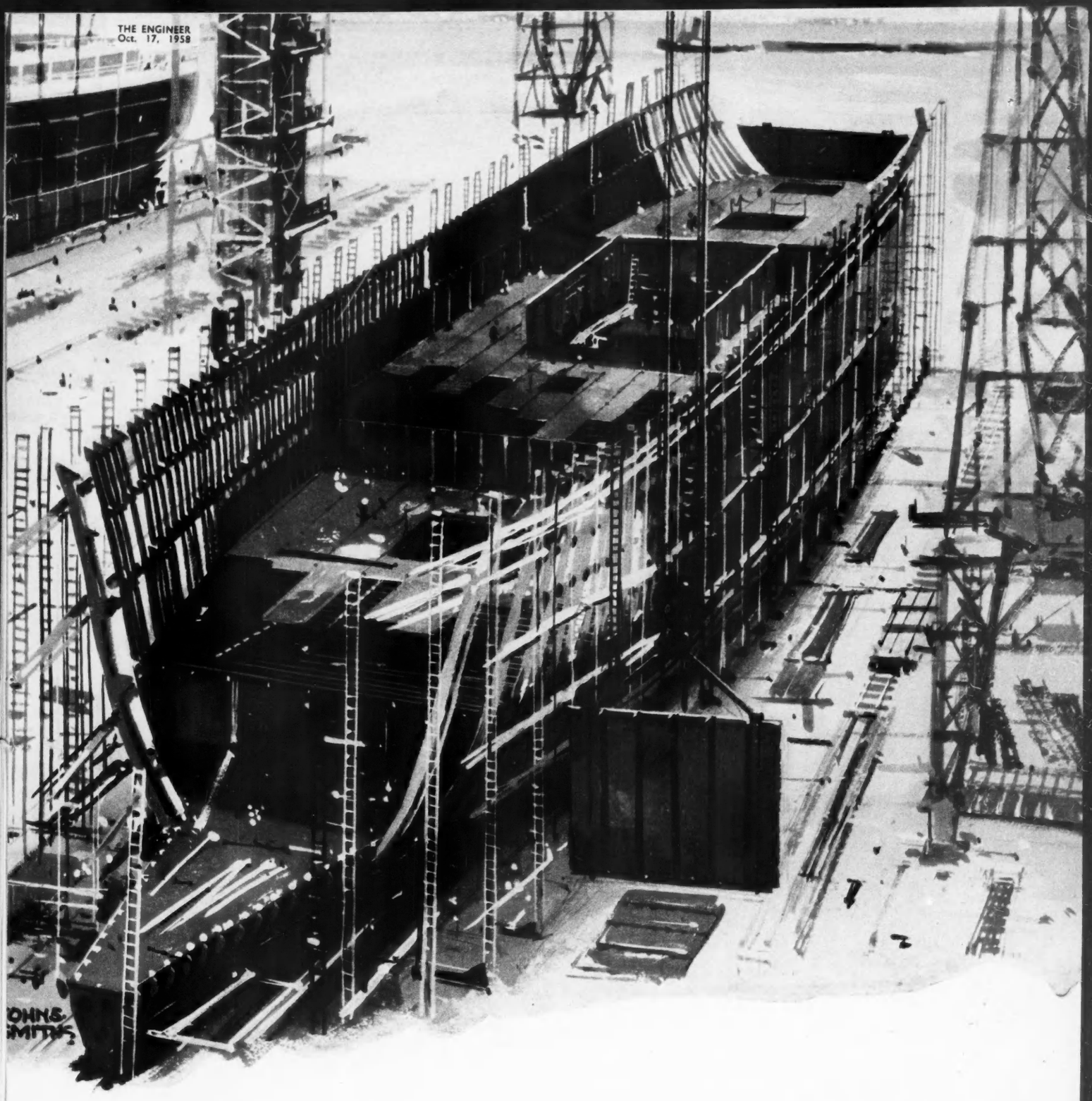

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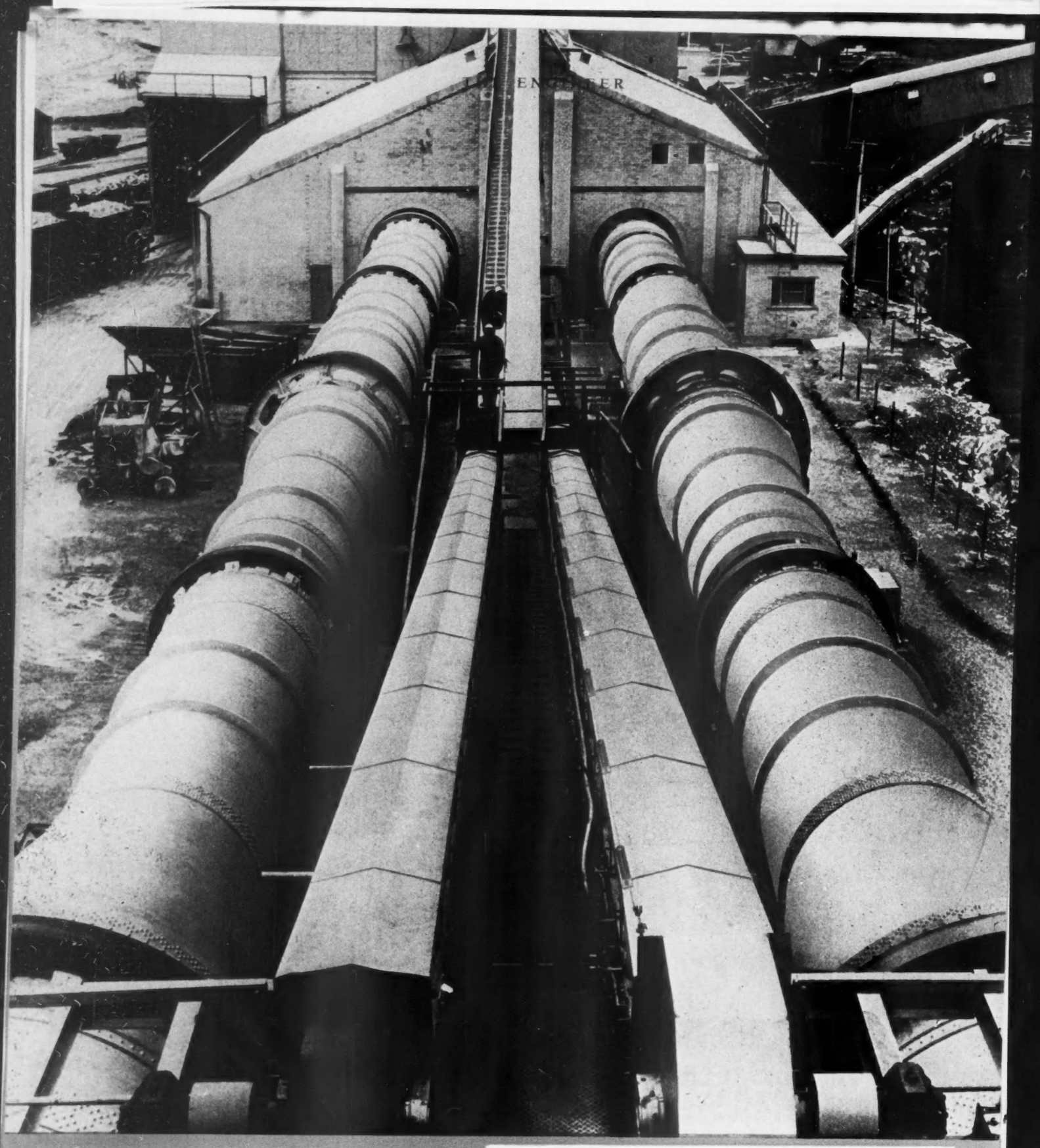

These Rotary Lime Kilns installed by Matthew Hall are 250 feet long and each has a maximum diameter of 13 feet 6 inches. They were made by Vickers Armstrongs and are in service at I.C.I.'s (Lime Division) Tunstead Quarry, Buxton and produce lime of high chemical purity.

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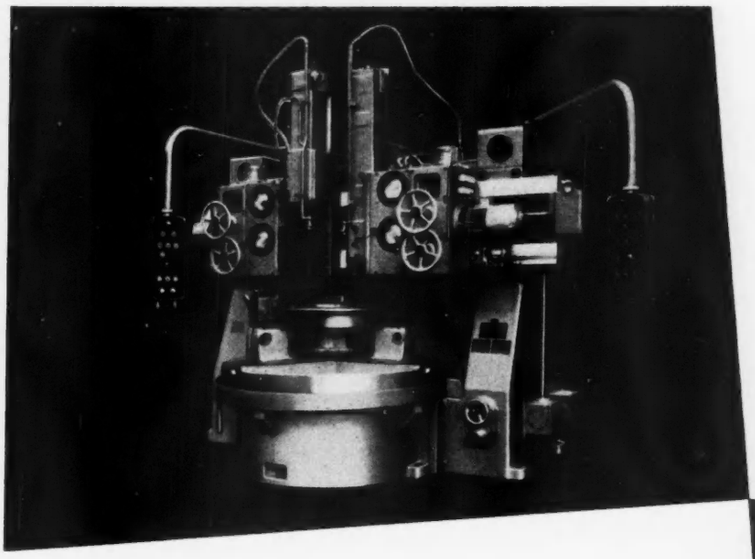
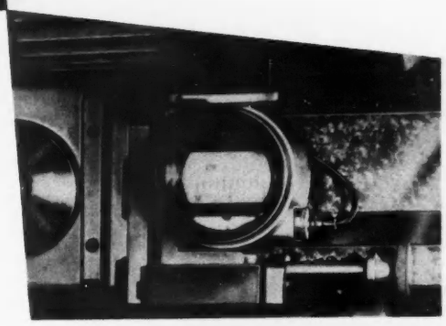


for boring carriage and locomotive wheel tyres, turning the lip and cutting the groove for the retaining ring.



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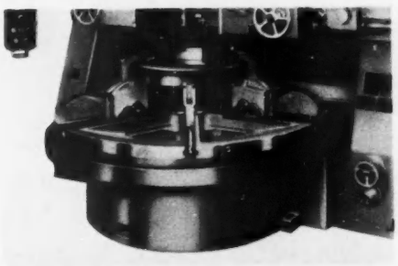

2

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Automatic machining cycle

Air-operated or semi-automatic mechanical chuck

The right hand head can be set to the bore diameter within a tolerance of .01 mm. by means of a HENSOLDT optical system

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Lip and retaining ring groove can be machined independently of each other, either horizontally or at an angle

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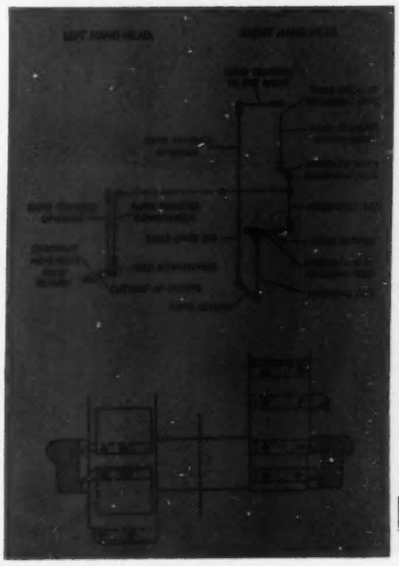

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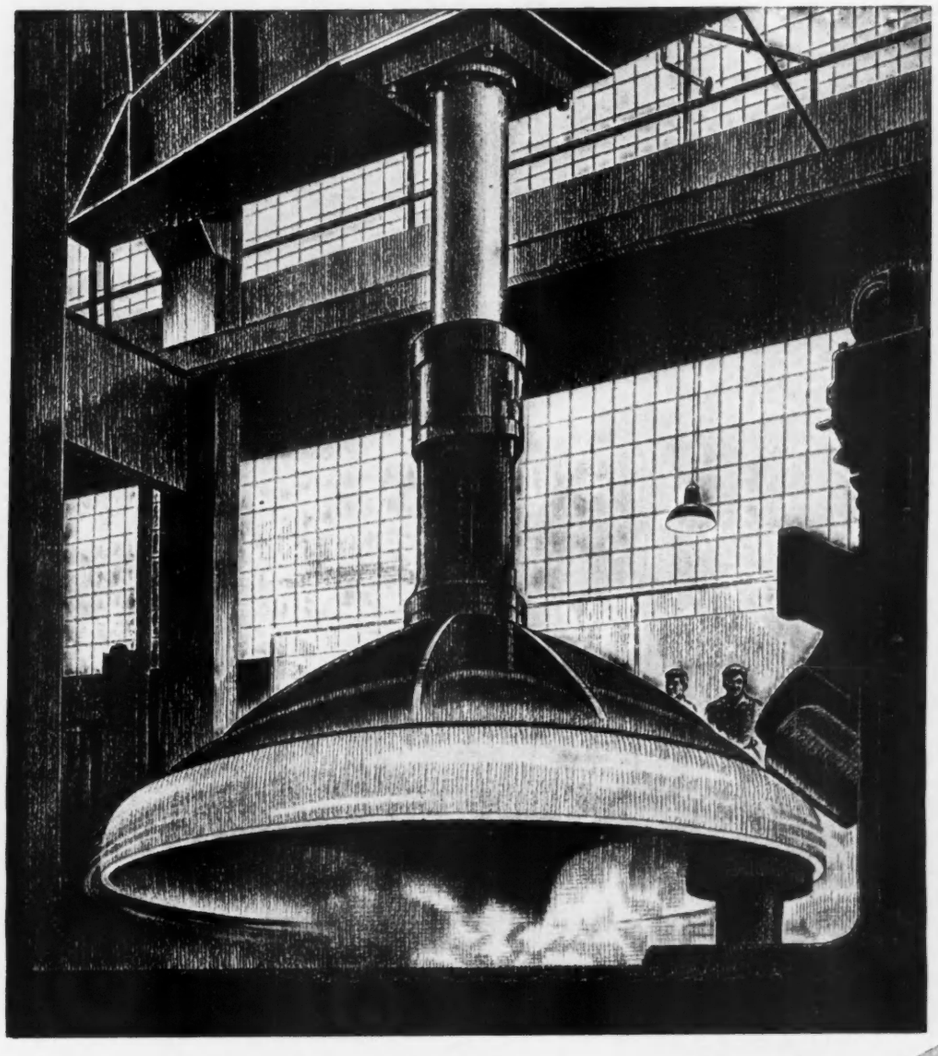

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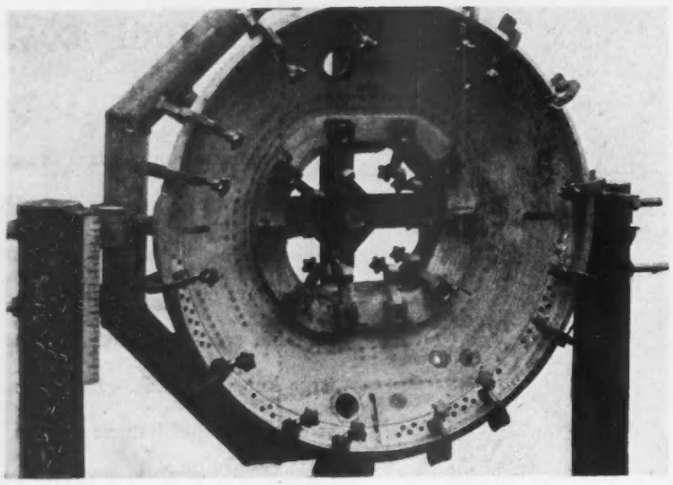

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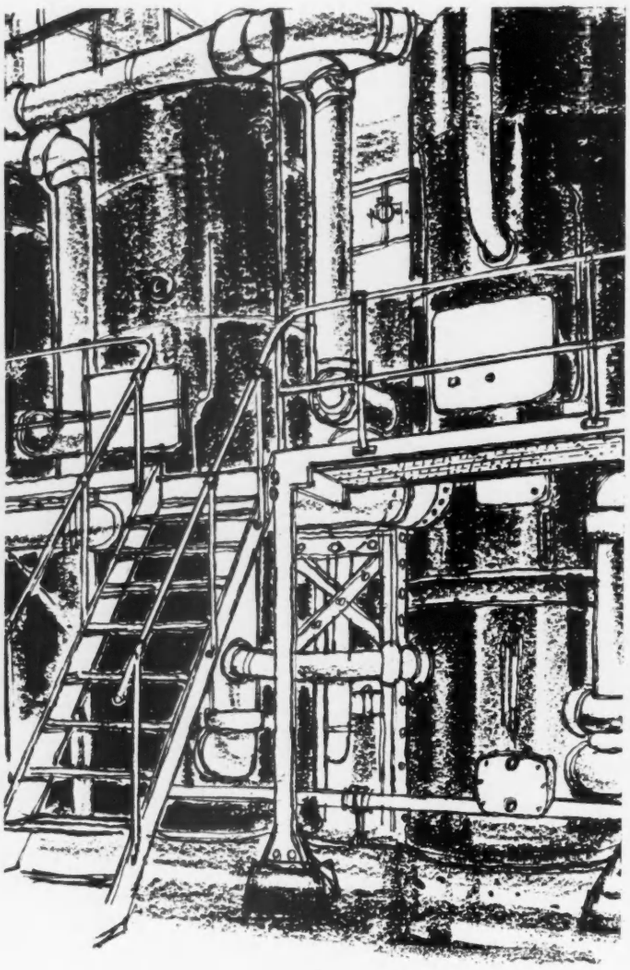

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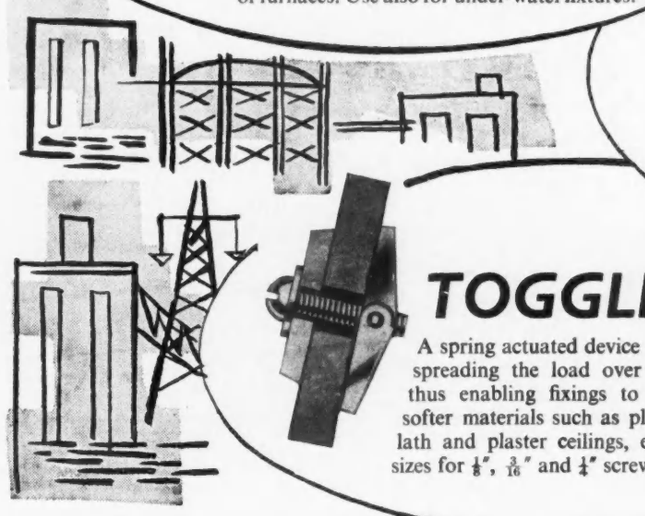

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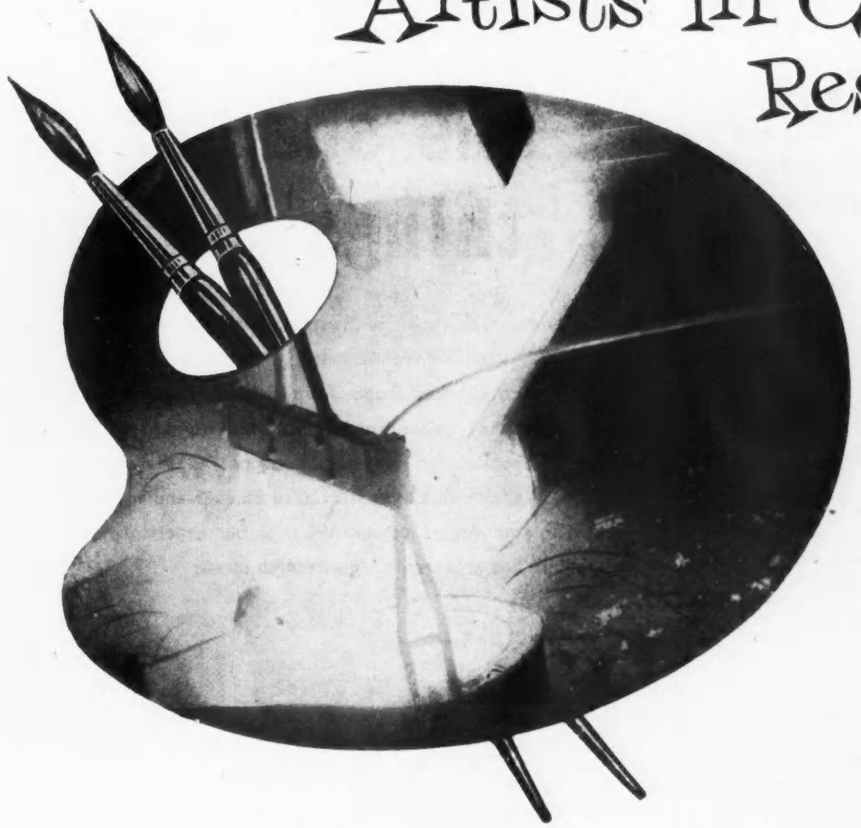

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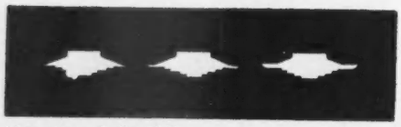

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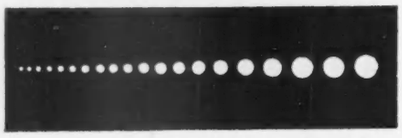

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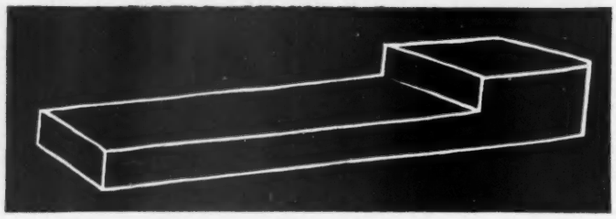

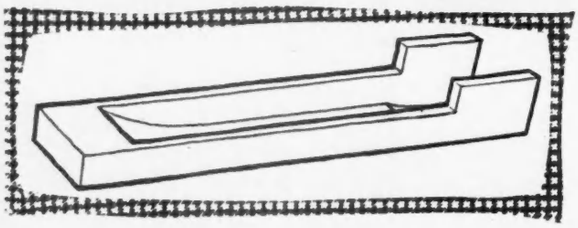

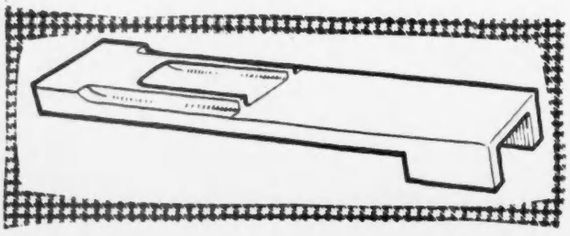

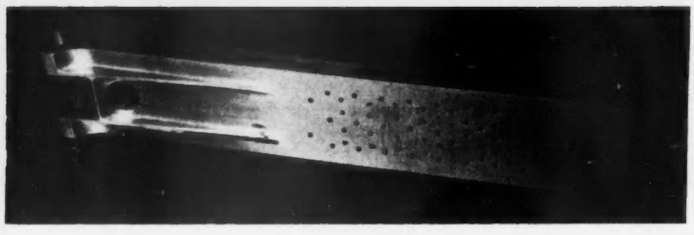

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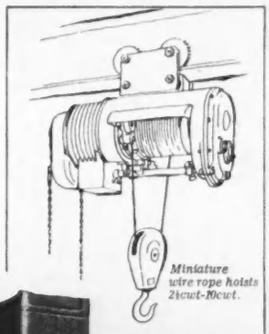
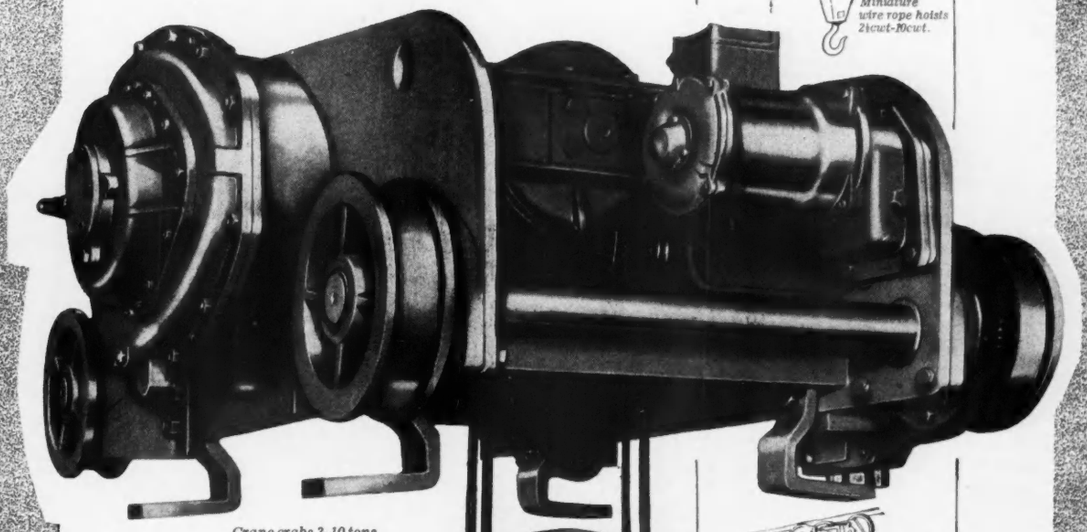


Miniature wire rope hoists 2½cwt-10cwt.



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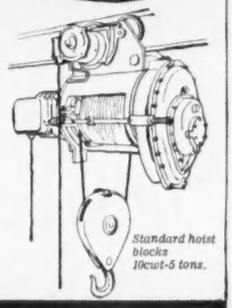

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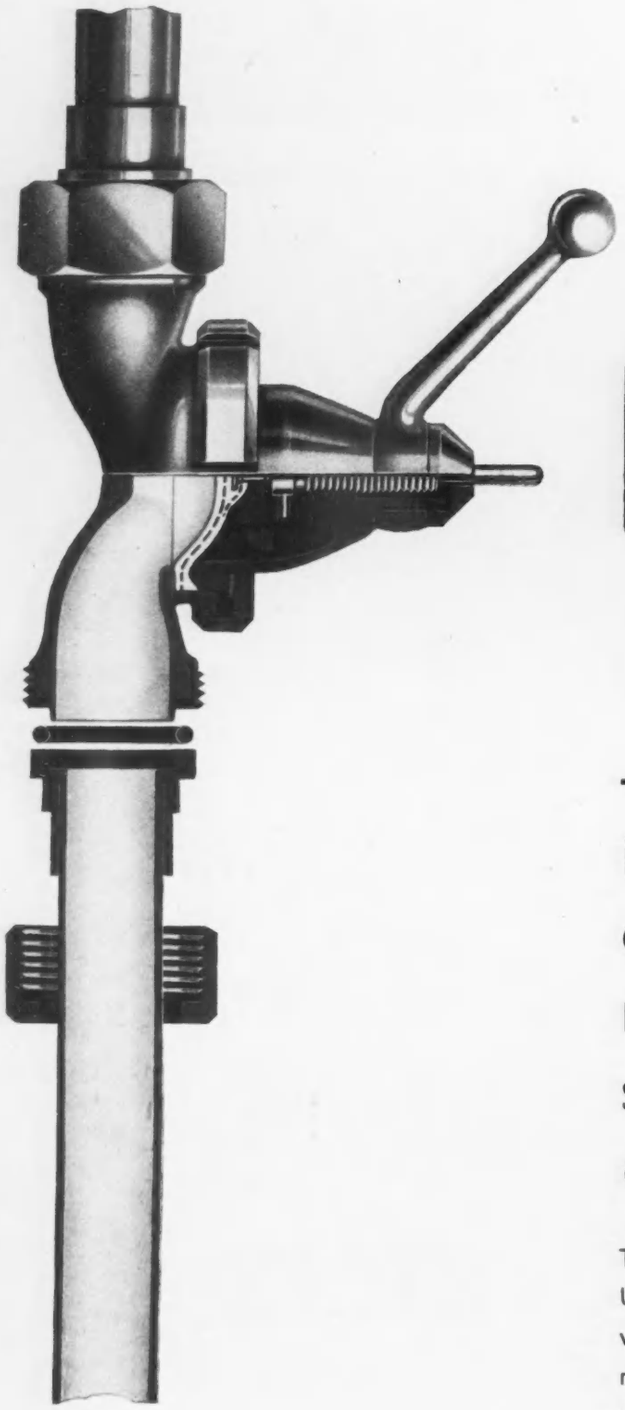

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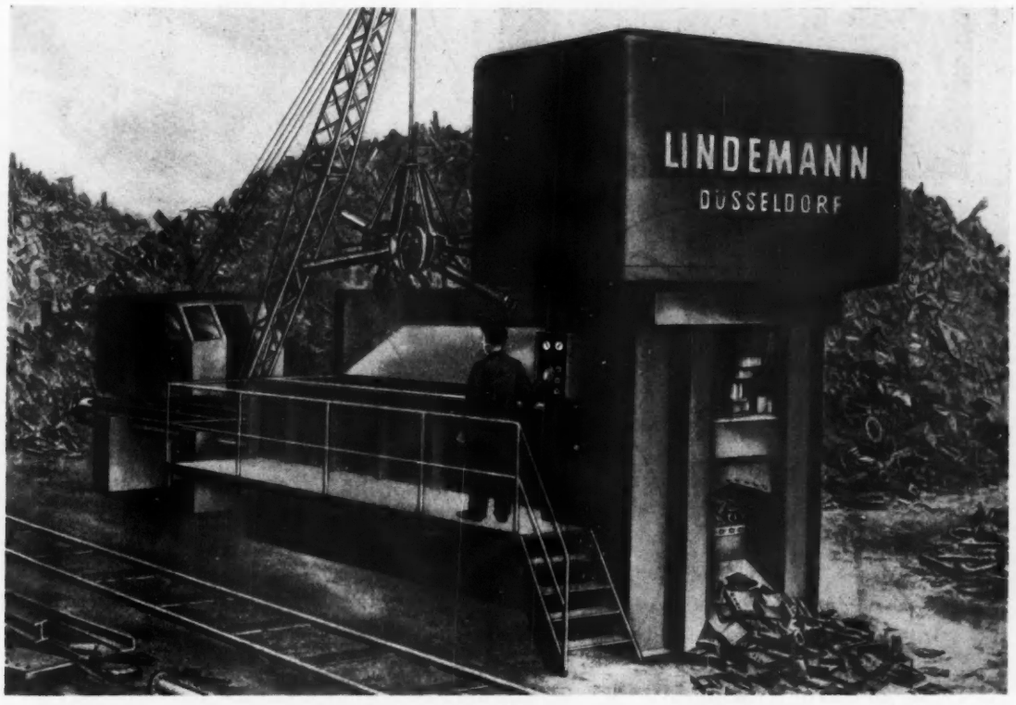

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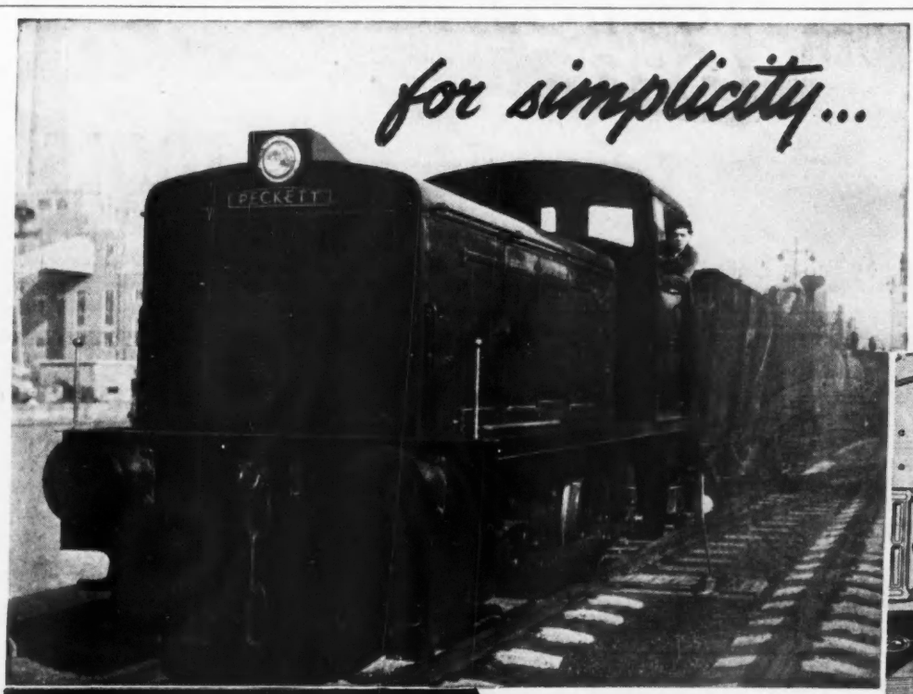

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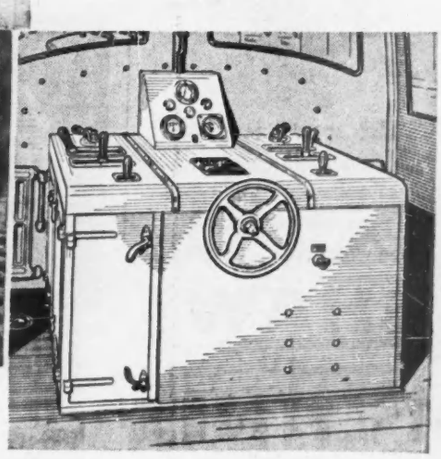

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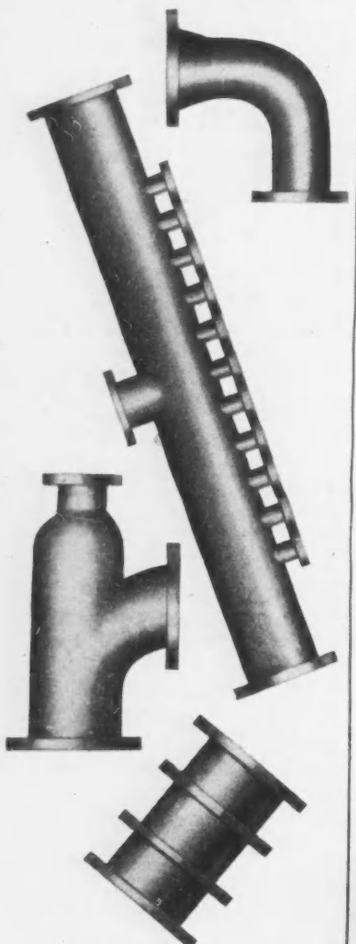

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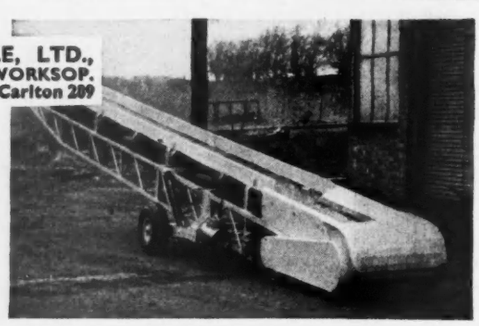

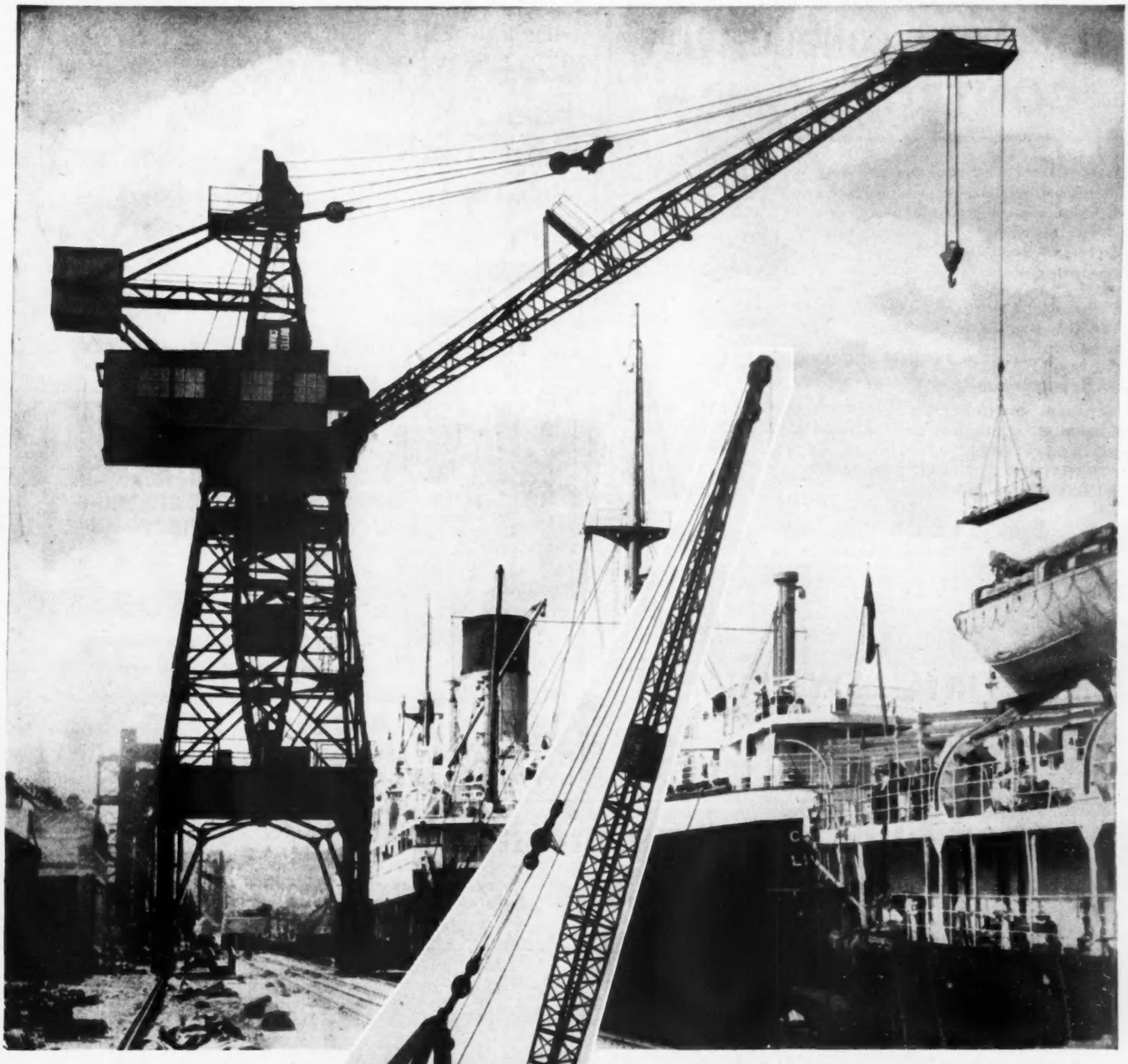

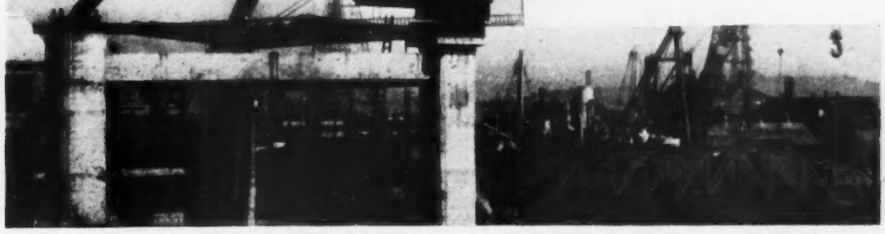

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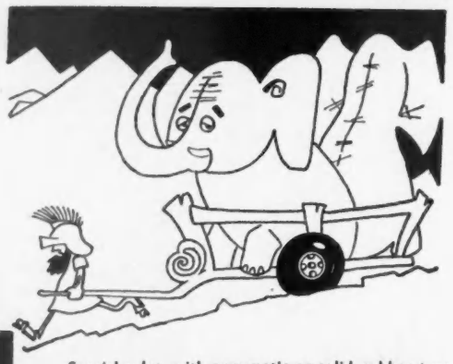

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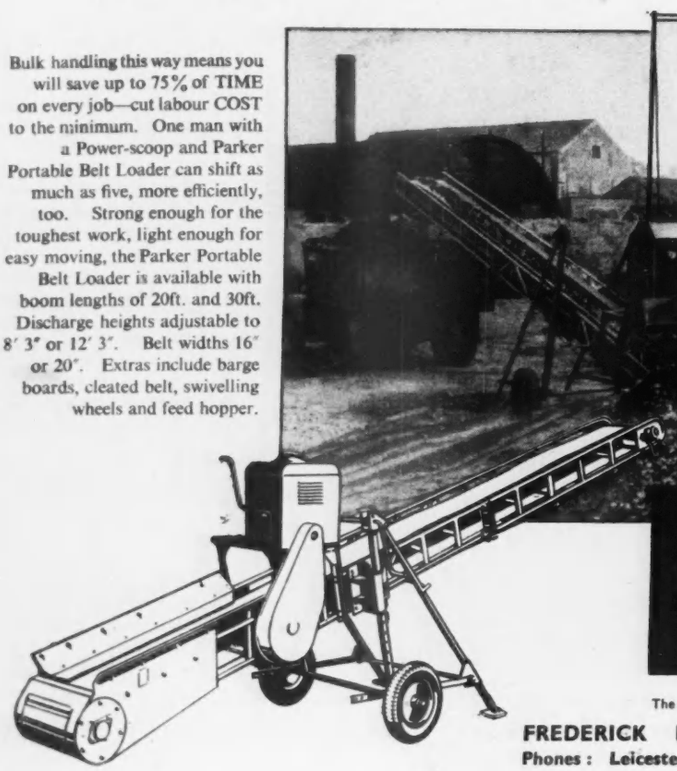

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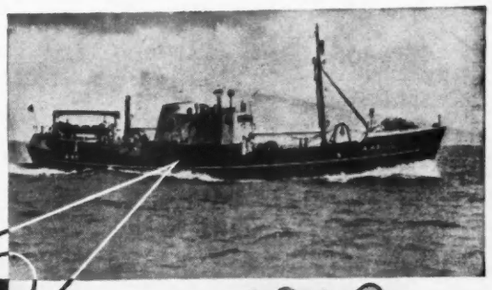

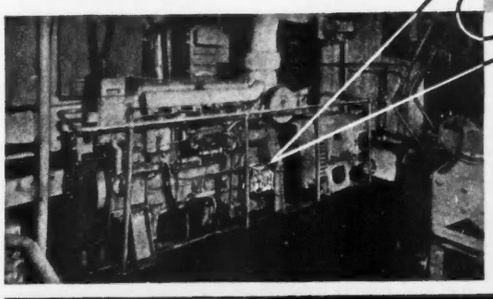

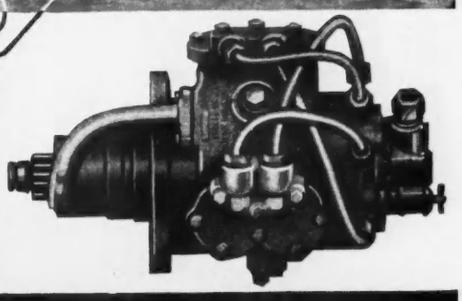

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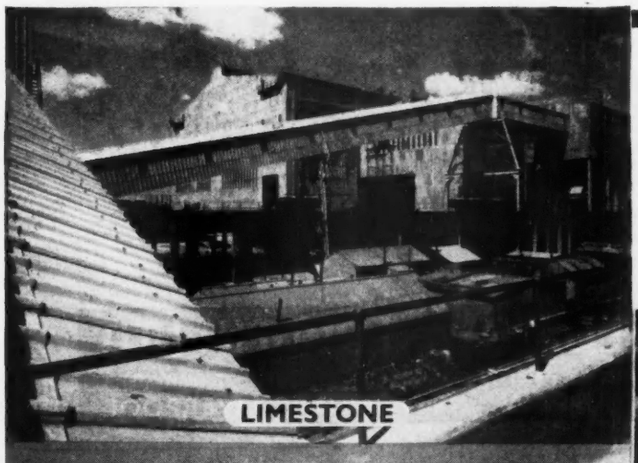

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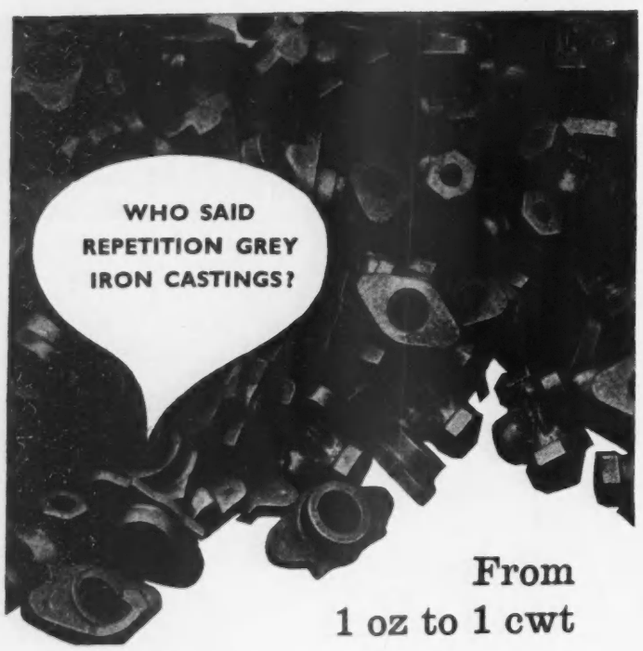

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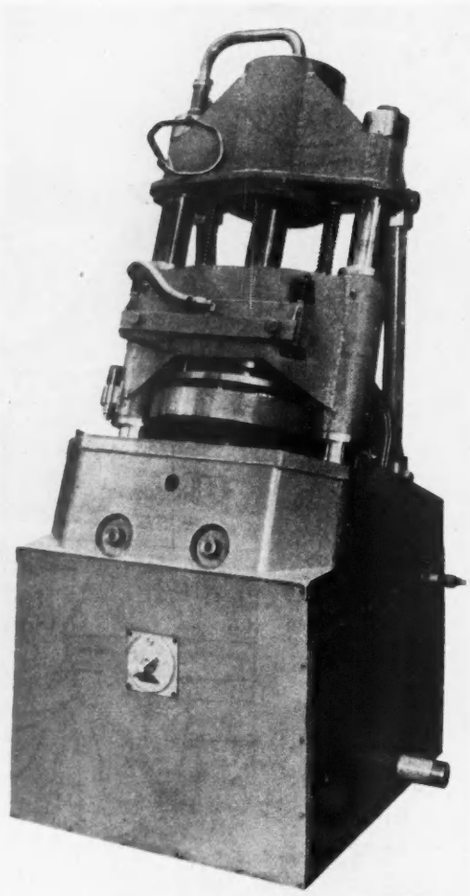

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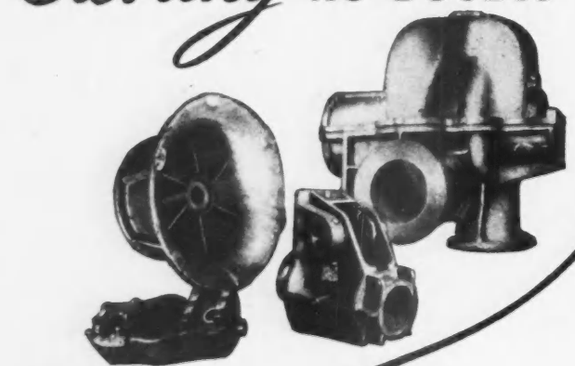

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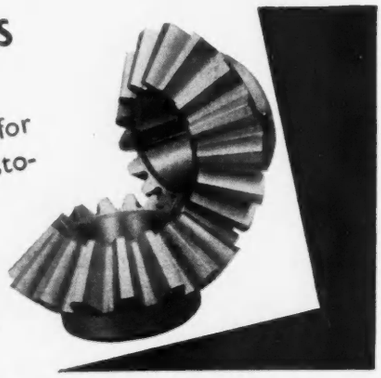

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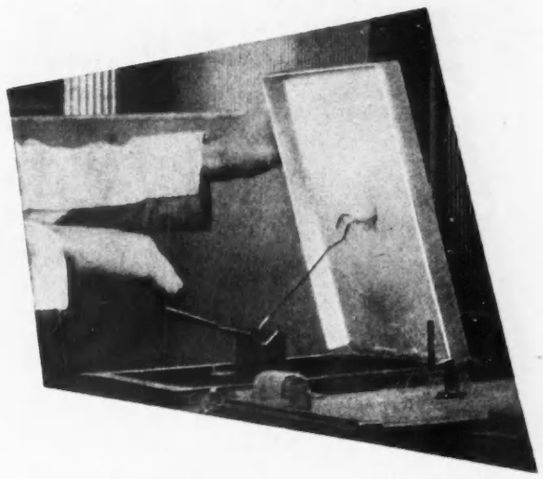

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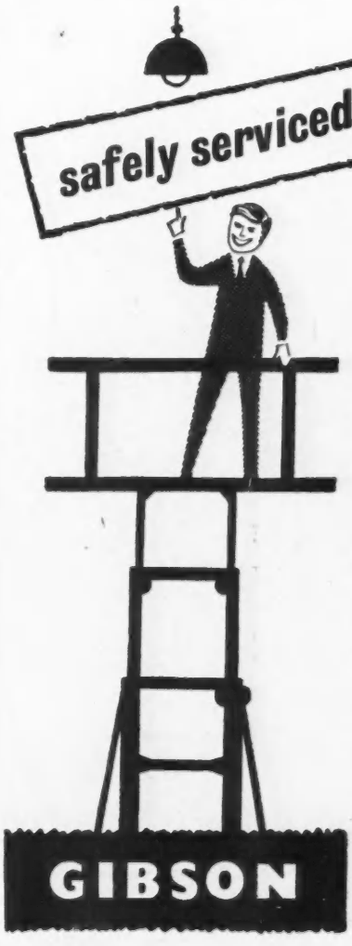

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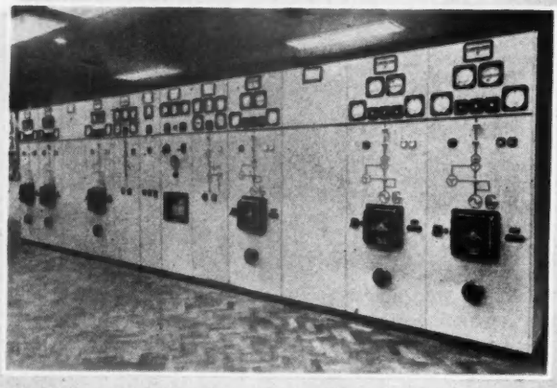

Photographs by courtesy of Rolls Royce Ltd.
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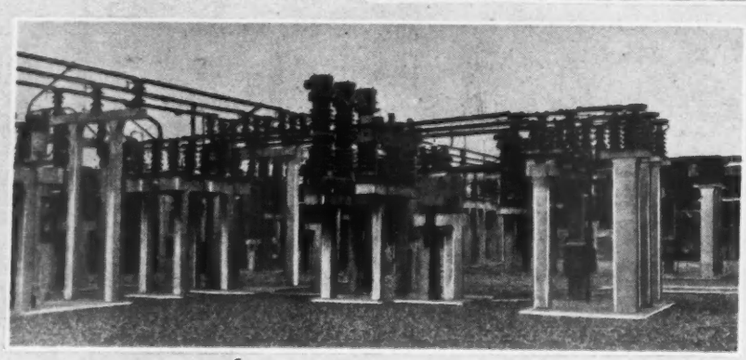

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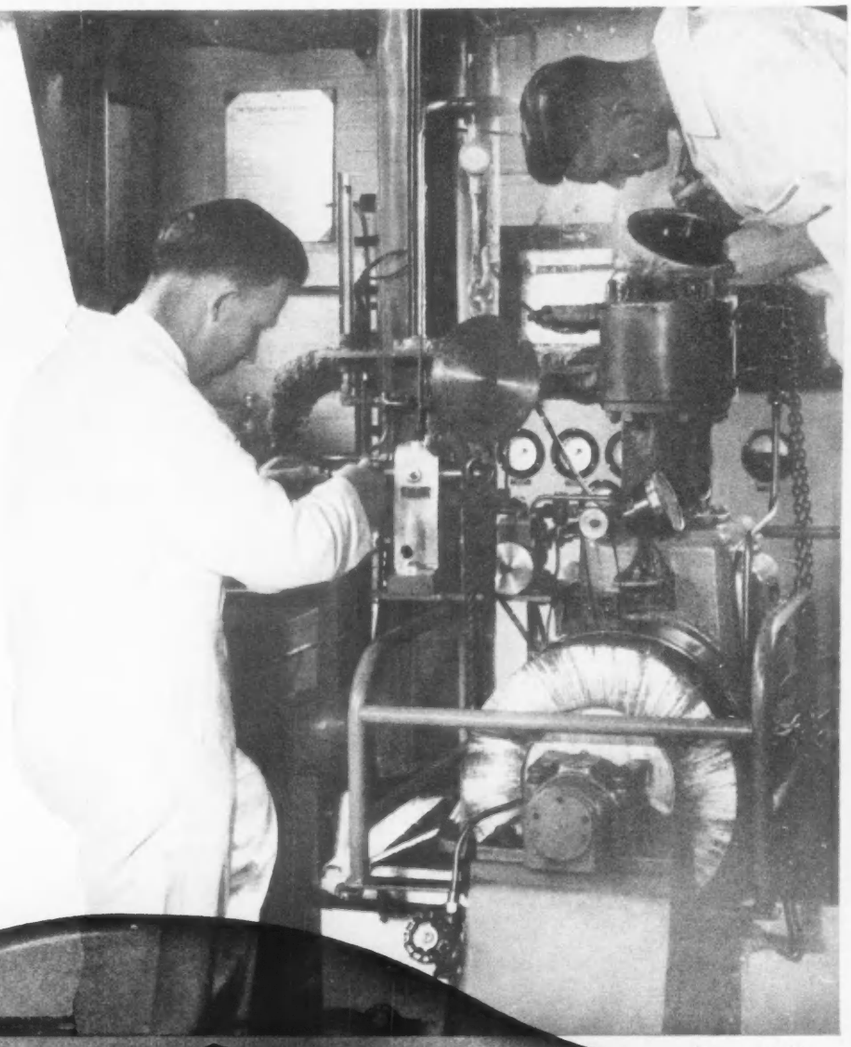

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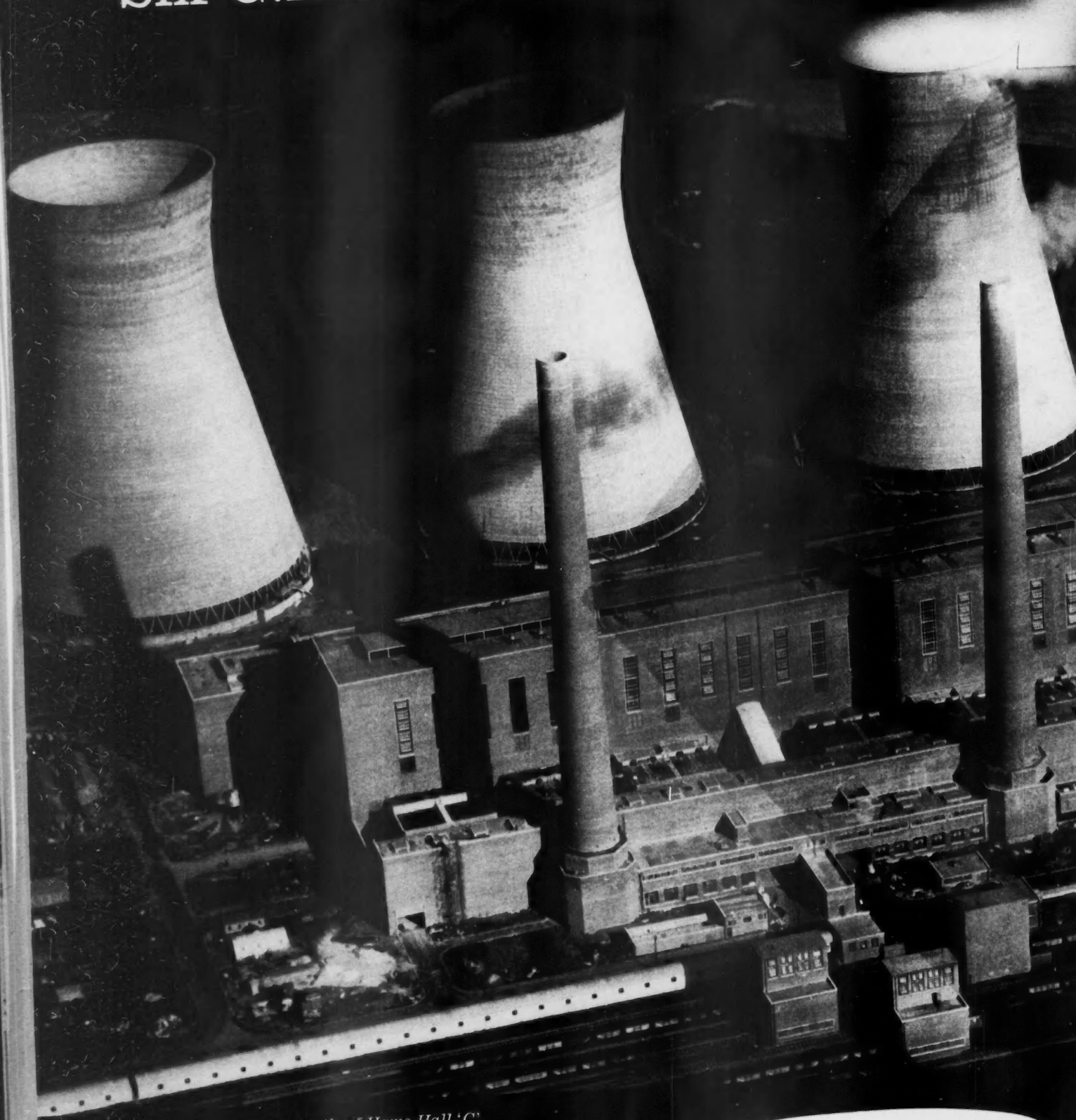
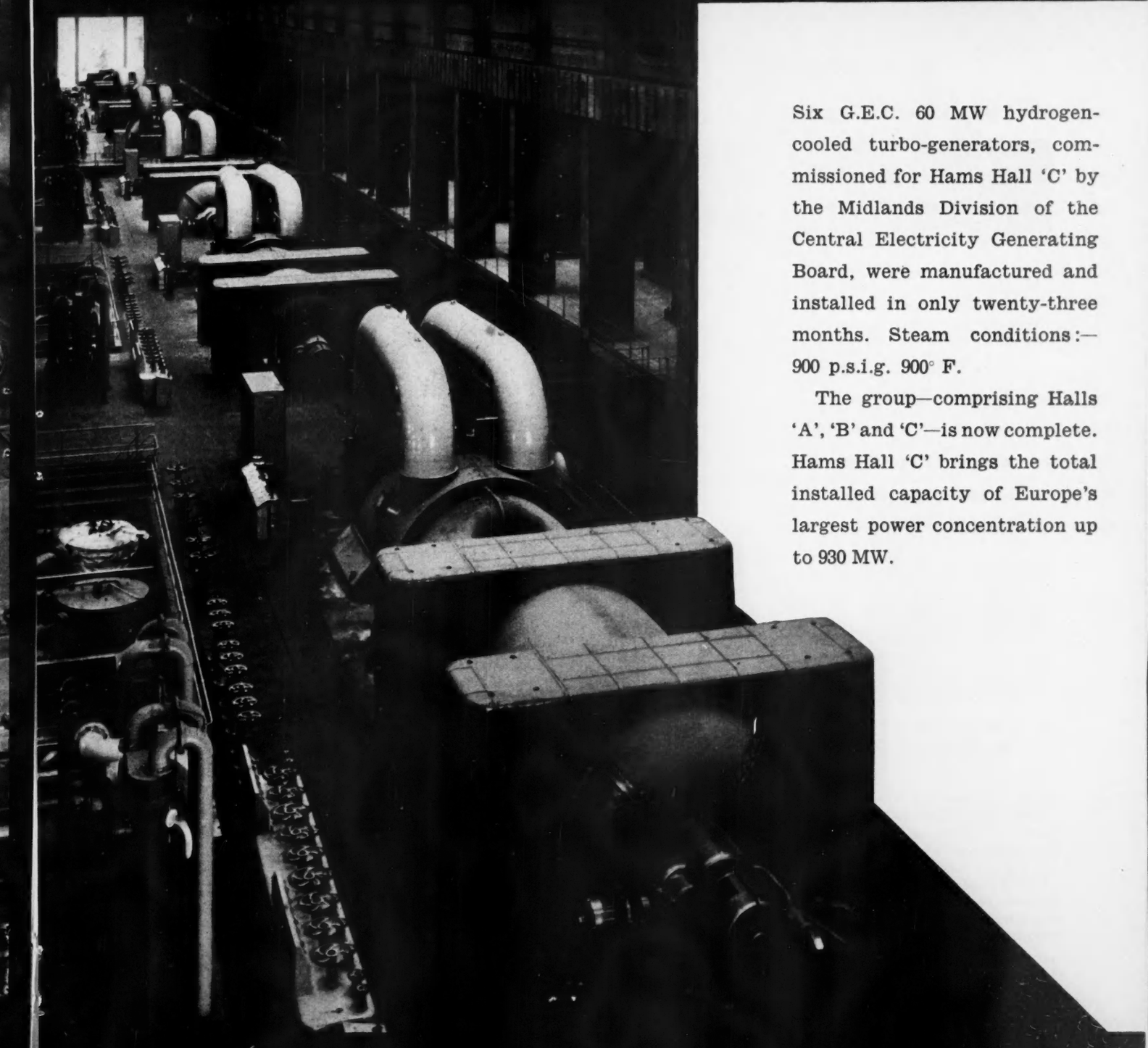


Aerial view looking north of Hams Hall 'C'.

G.E.C.

largest power concentration



Six G.E.C. 60 MW hydrogen-cooled turbo-generators, commissioned for Hams Hall 'C' by the Midlands Division of the Central Electricity Generating Board, were manufactured and installed in only twenty-three months. Steam conditions:—900 p.s.i.g. 900° F.

The group—comprising Halls 'A', 'B' and 'C'—is now complete. Hams Hall 'C' brings the total installed capacity of Europe's largest power concentration up to 930 MW.

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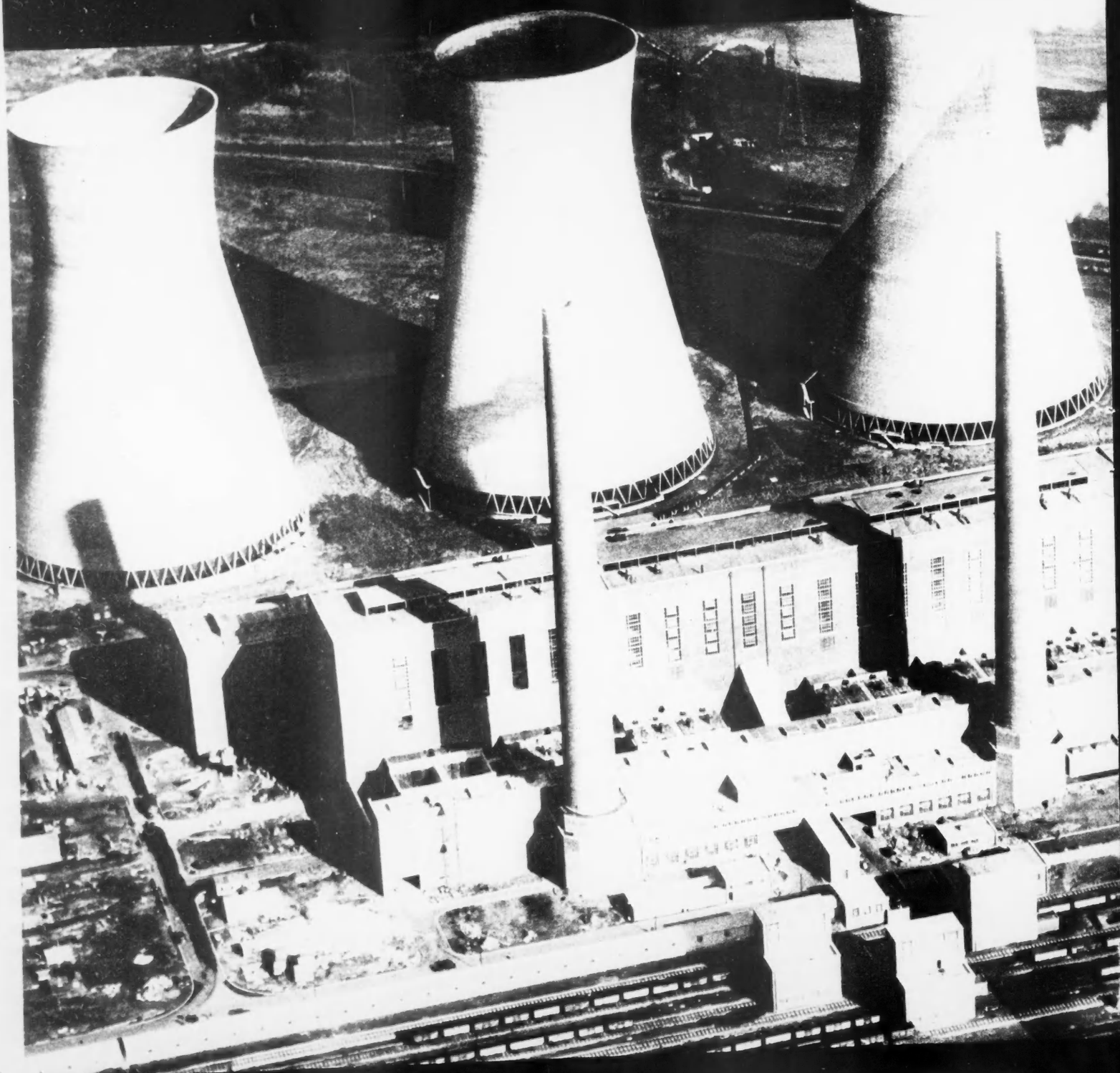

Aerial view looking north of Hams Hall 'C'.

G.E.C.

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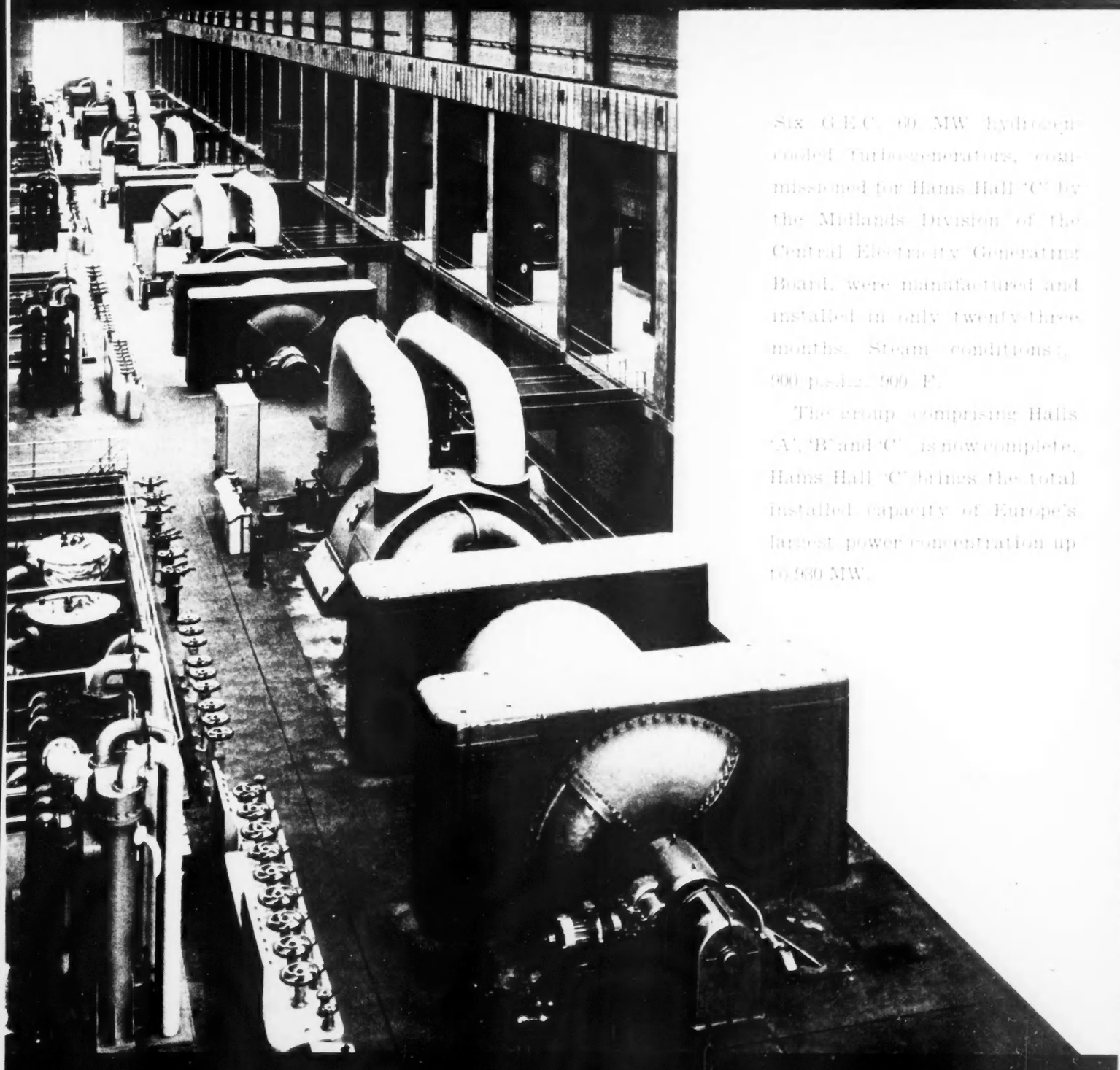

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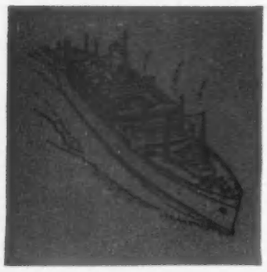
ENGINEERING WITH A BACKGROUND



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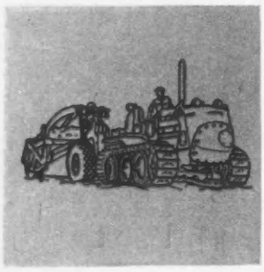

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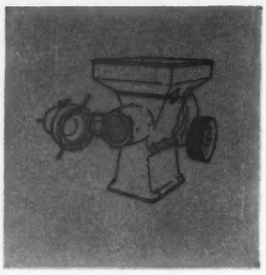

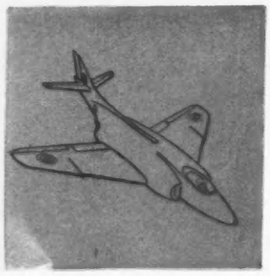

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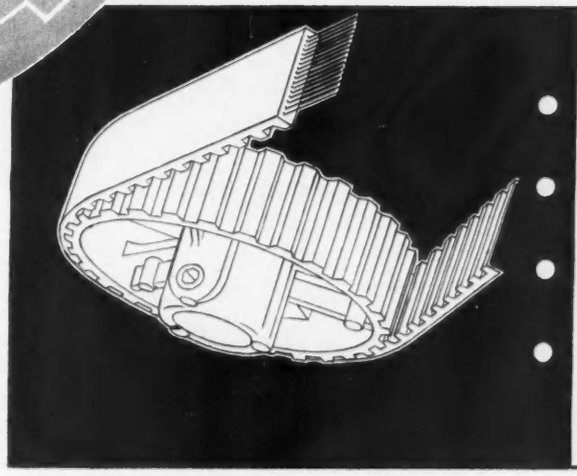

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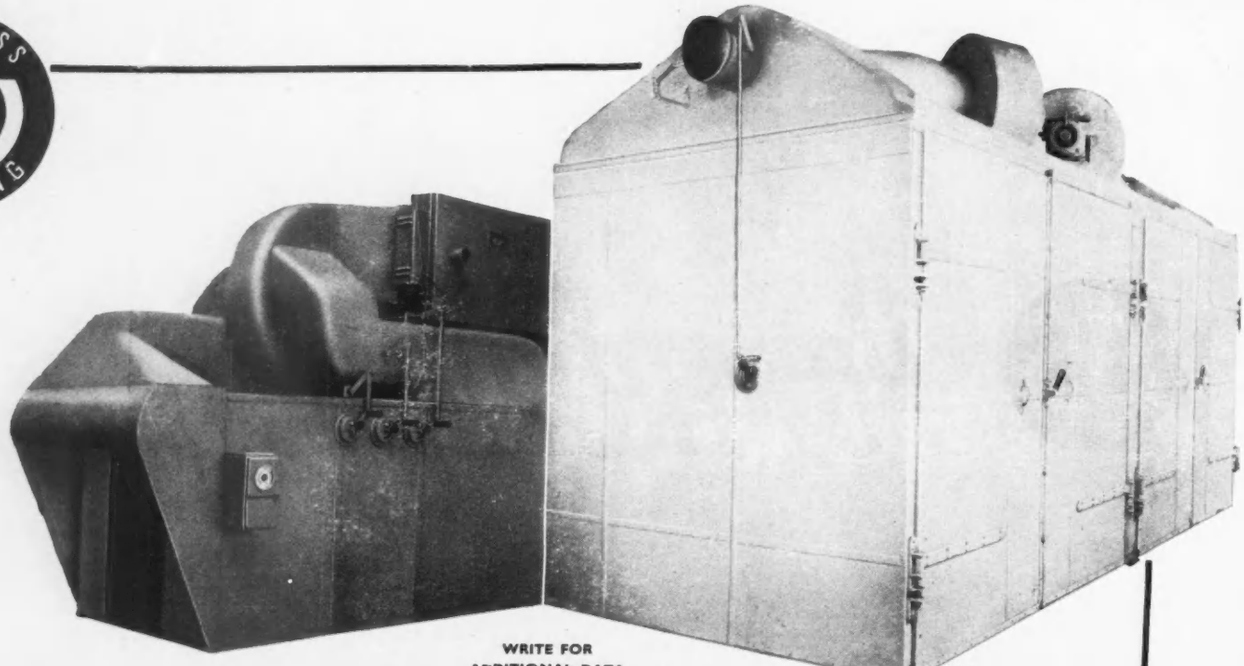

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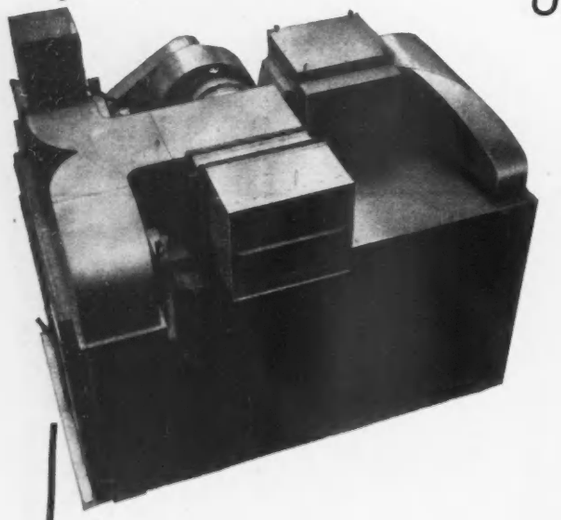

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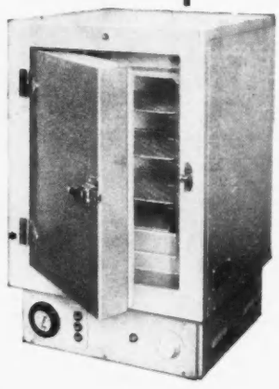

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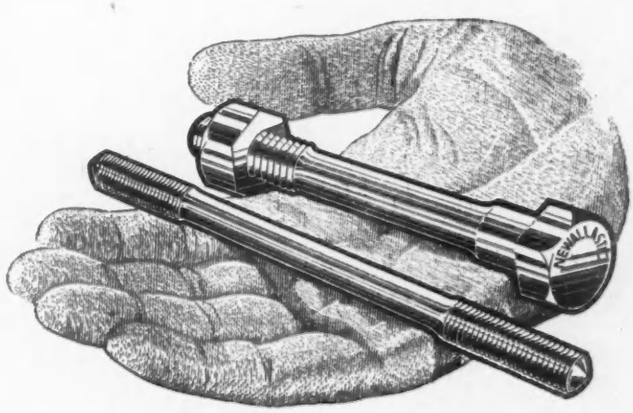

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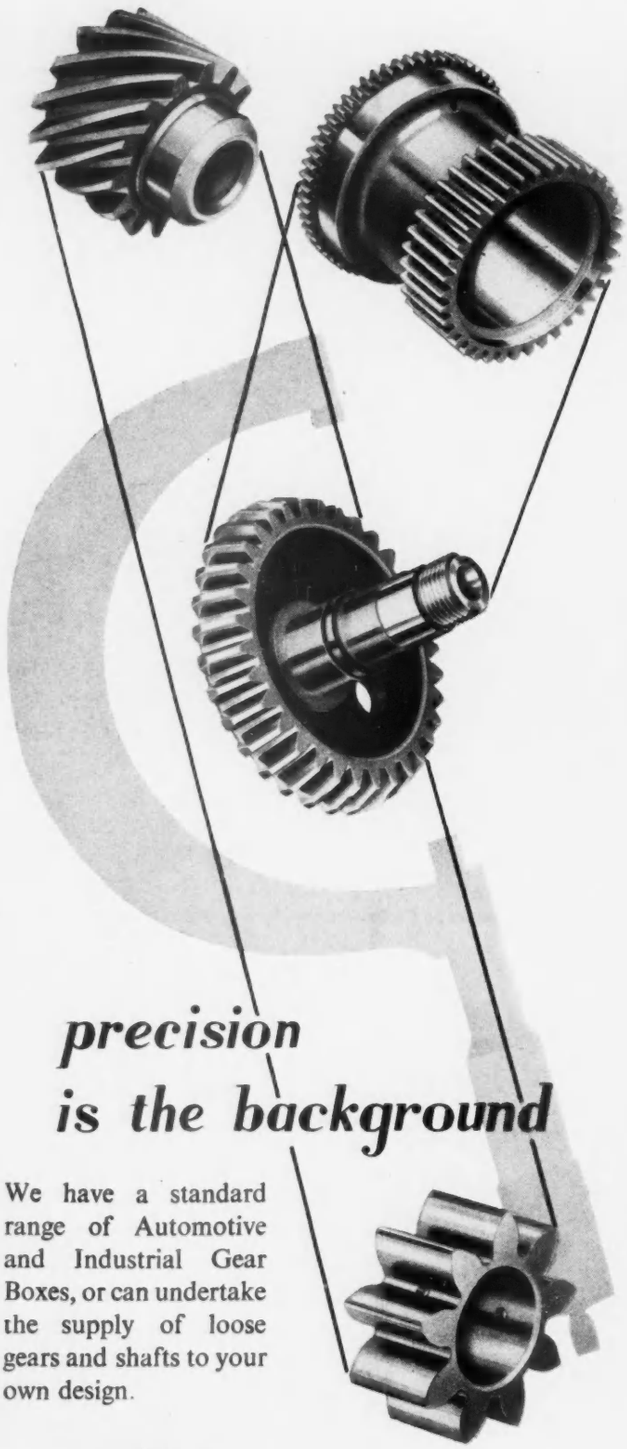

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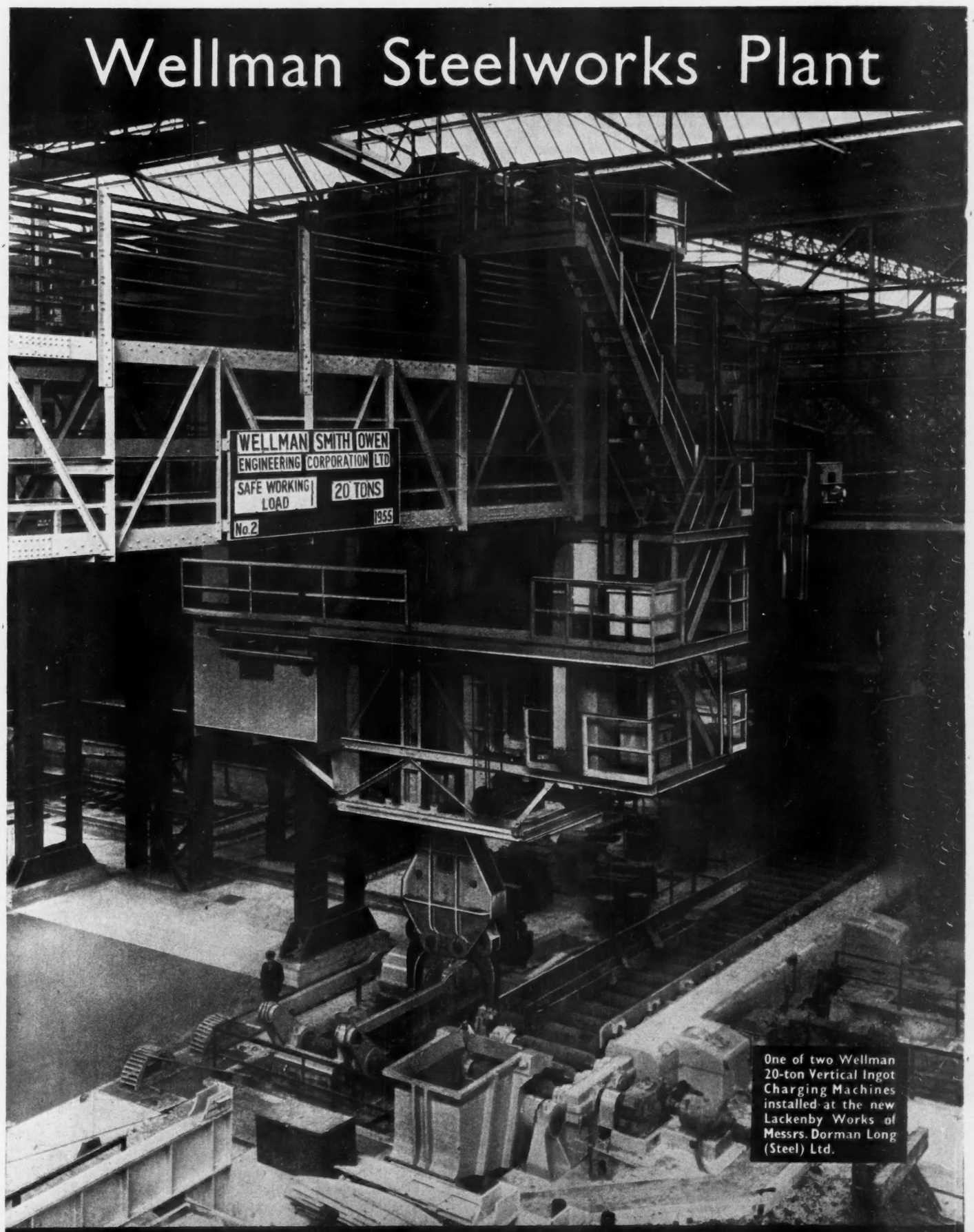

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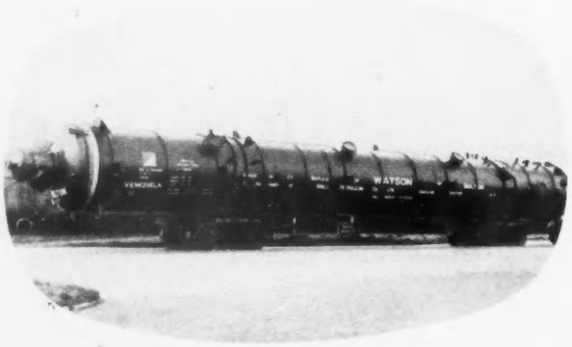

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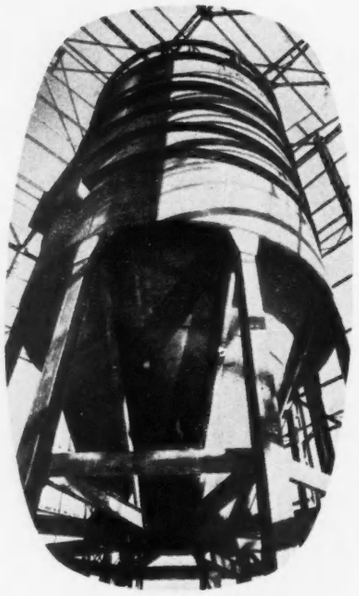

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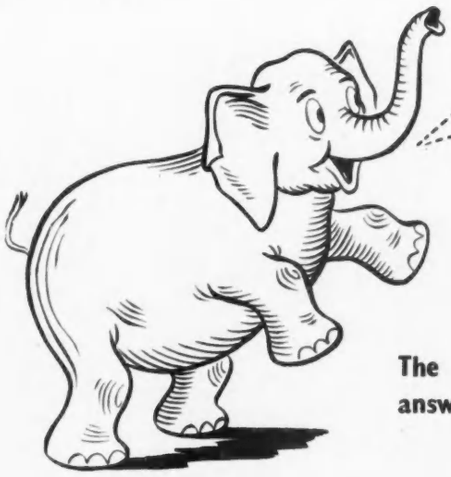

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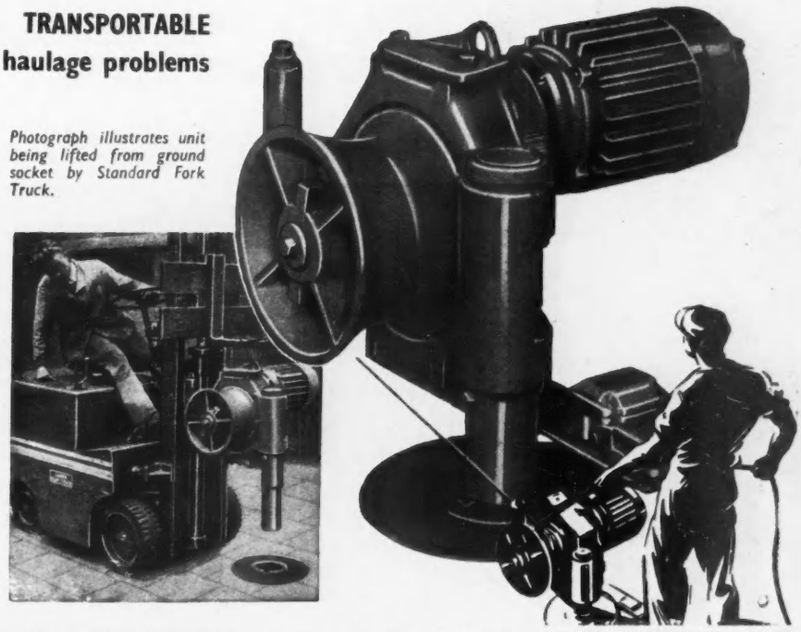
Photograph illustrates unit being lifted from ground socket by Standard Fork Truck.



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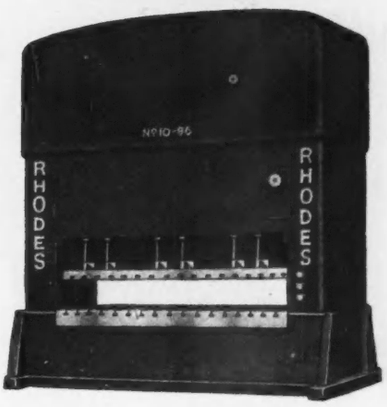

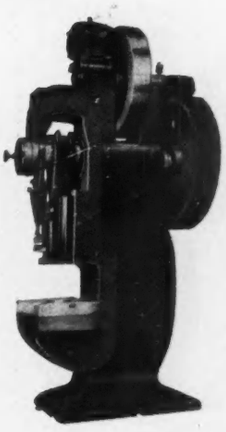

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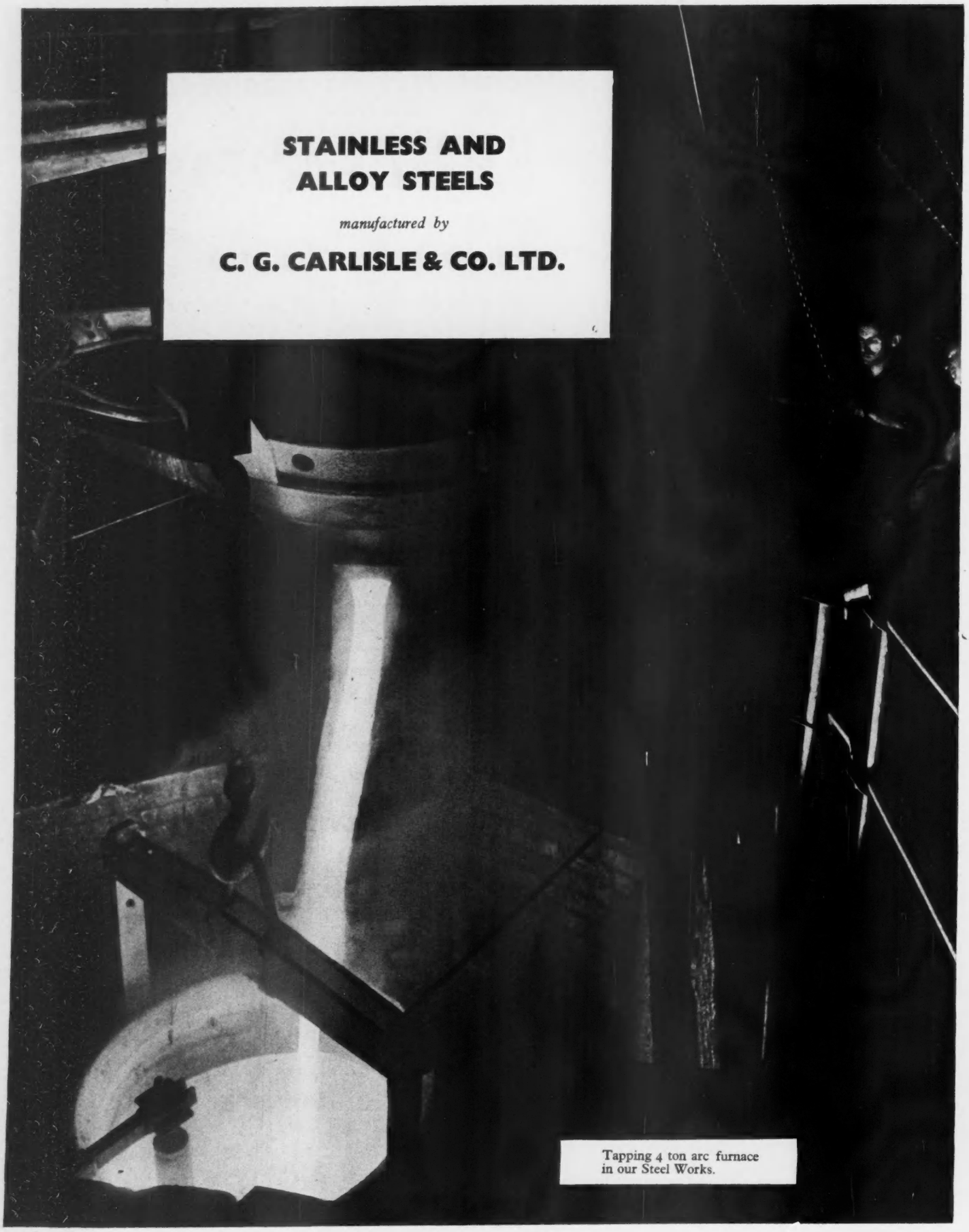

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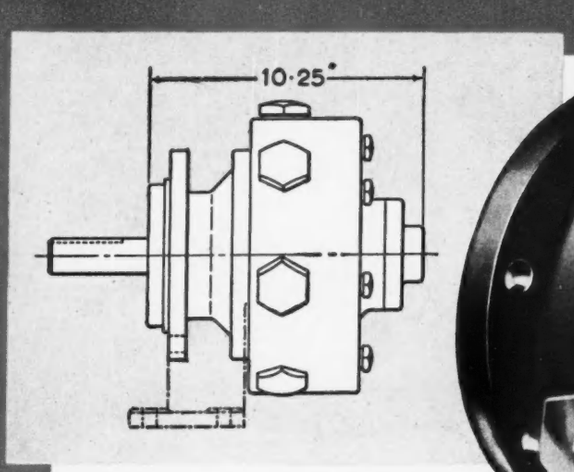

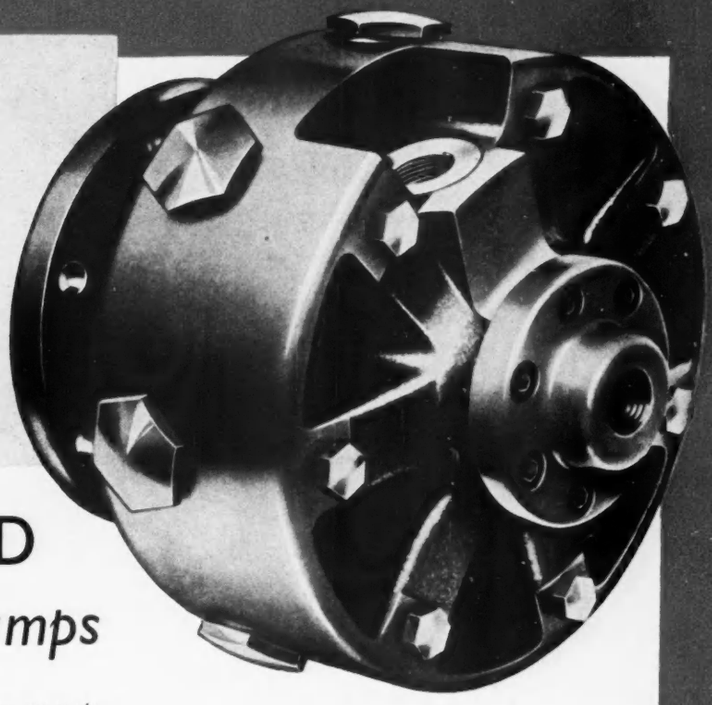

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While primarily intended for direct coupling to suitable electric motors, this unit, being of piston type, retains high efficiency at low speeds. The design not only incorporates all features necessary for long life under full load conditions, but has produced a unit in which ease of servicing and fitting replacement parts is outstanding.

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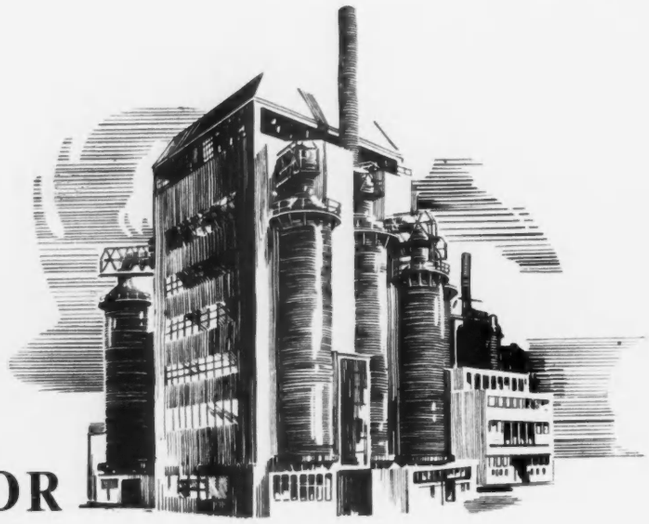

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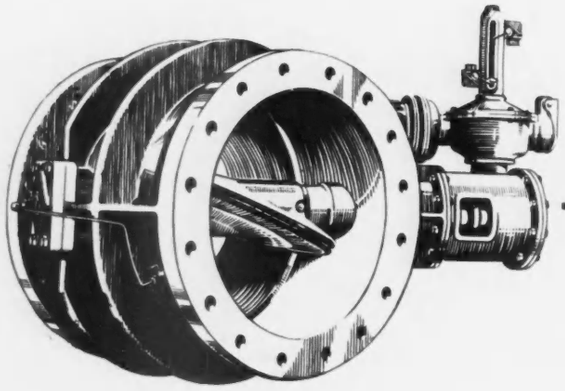
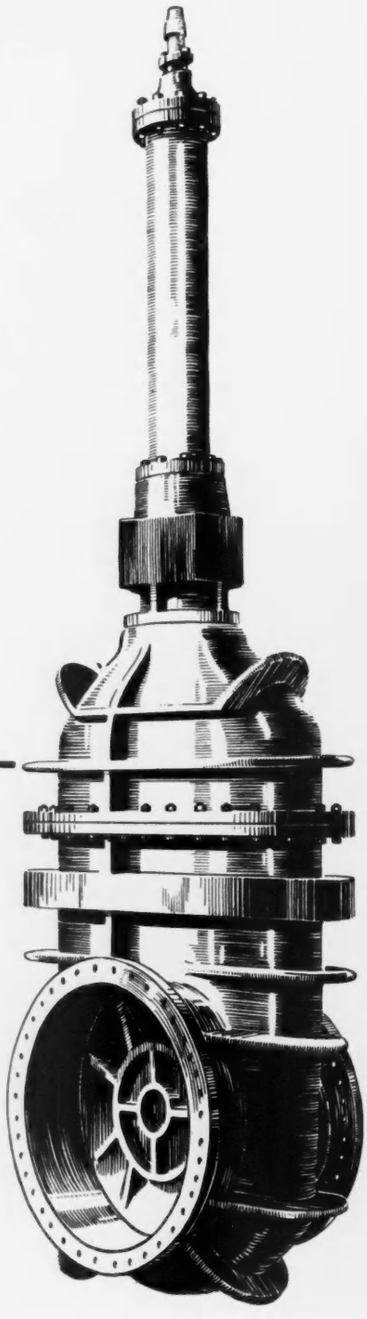
NUCLEAR REACTOR COOLANT SYSTEMS

Valve production has for long been a Glenfield specialty, and over the years we have evolved many new designs to suit new conditions of service. With our expert knowledge and up-to-date manufacturing facilities, we are well placed to meet the need for special units for flow control and associated purposes in Nuclear Reactor Coolant Systems.

Already we have produced acceptable designs for current requirements, and are fully prepared to investigate those of the future.





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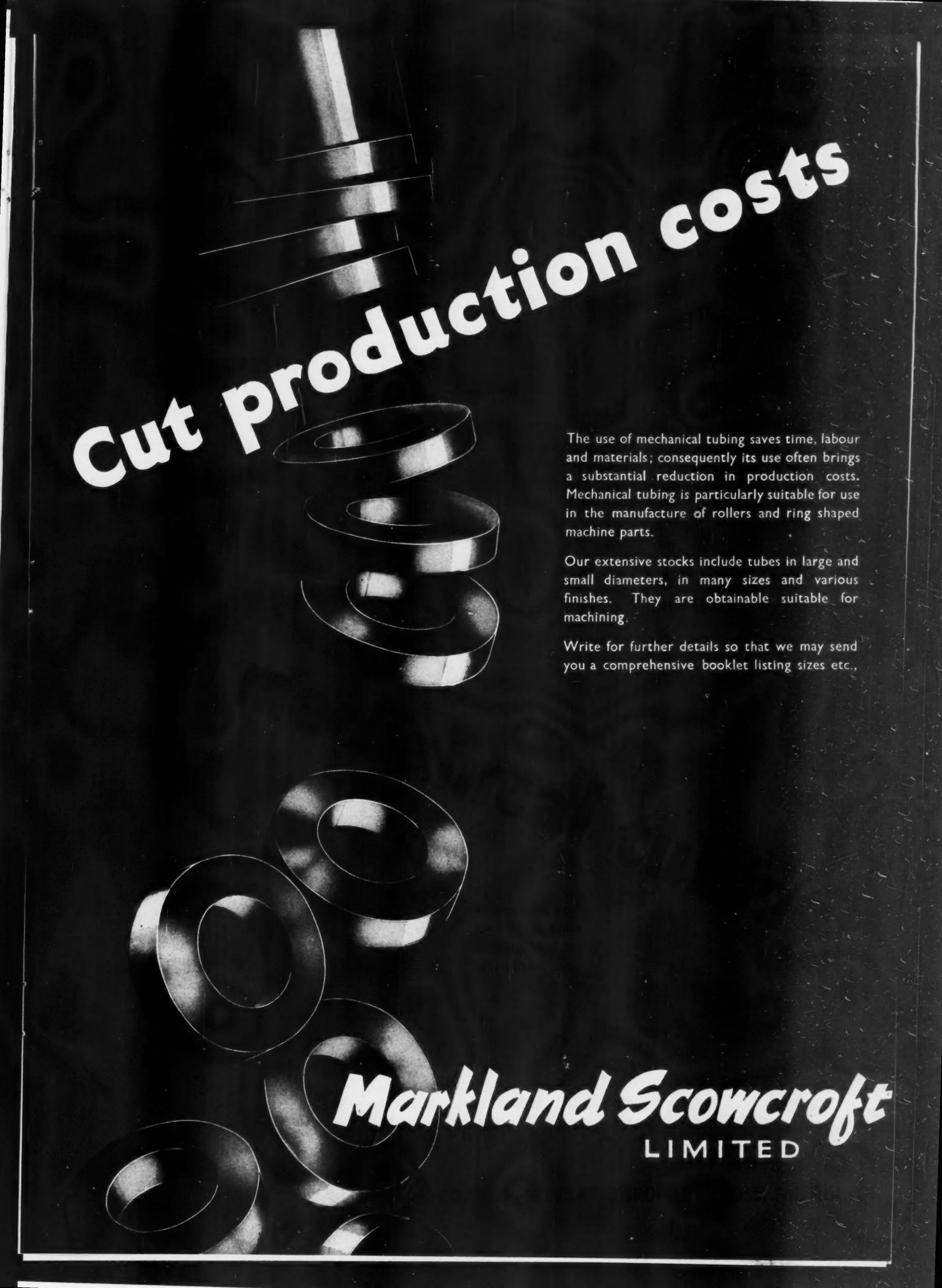
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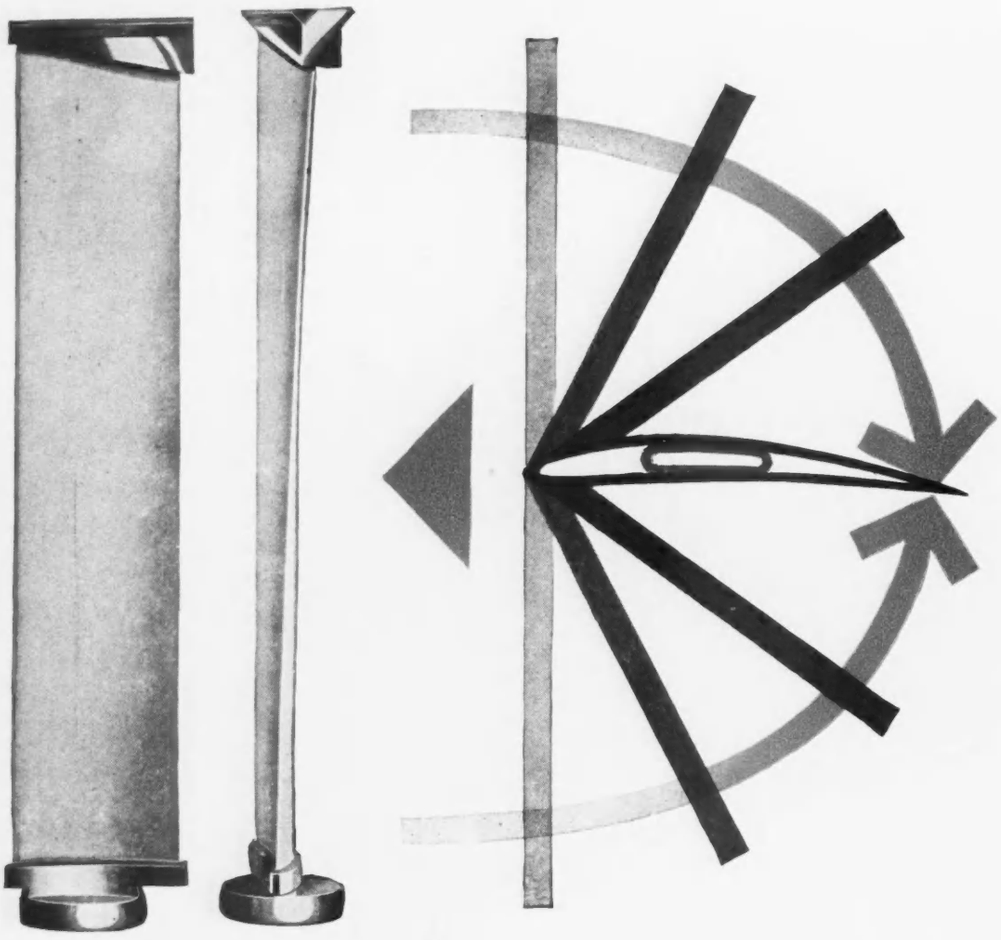


The illustration is shown by courtesy of Armstrong Siddeley Motors Ltd.

A new way with Hollow Blades

Wilmot Breeden, interested in the manipulation of metal in the cold state, have developed in co-operation with famous jet engine firms a new process for the manufacture of inlet guide vanes and stator blades. These envelopes are now formed in nickel-chrome alloys in a succession of press operations from a flat blank, the trailing edge being brazed—in a controlled protective atmosphere—to extremely close tolerances, leaving a minimum of material to be removed and eliminating any risk of weakening the joint.

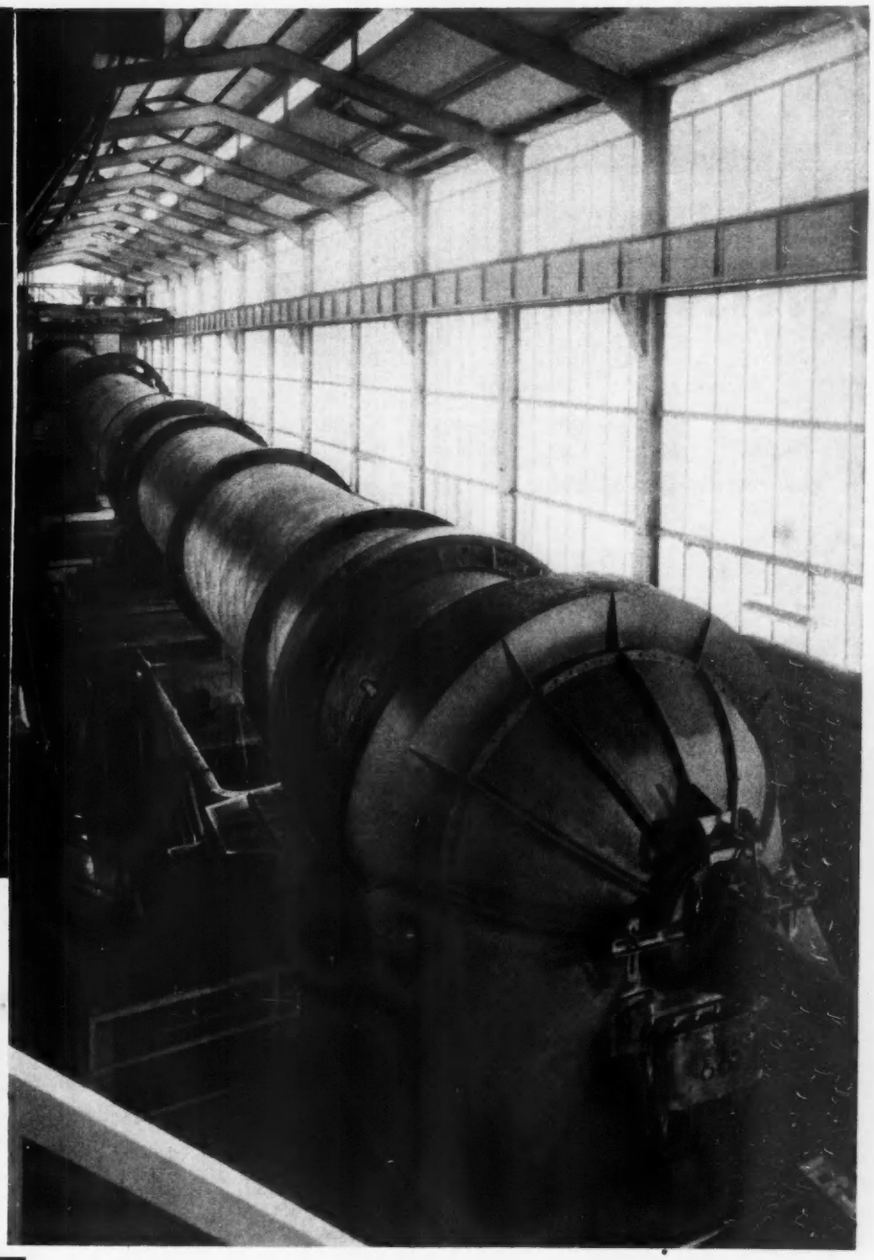
The inlet guide vanes and stator blades determine the direction of flow of the air entering and passing through the compressor to the combustion chambers. Accuracy of the envelope is vital, particularly so at the trailing edge. The vane is anti-iced by passing hot air through it. This air is distributed by means of one or more perforated ducts, which may form strengthening members, positioned within the envelope. The benefits of this process are: minimum weight for given envelope size, full response to aerofoil requirements, maximum heat transfer because of uniform wall thickness, ease of accommodating end fixings of widely differing design.

The illustration shows an inlet guide vane for a Sapphire engine; the envelope and the single air duct of this blade are of stainless steel as are the spherical end bearing and the dovetail at the root end. Both end fixings are machined and ground to close tolerances after being brazed into position by induction heating.

If you have an application for this new method we should be pleased to investigate and advise.

Wilmot Breeden are skilled in metal manipulation

Wilmot Breeden Ltd, Birmingham 1



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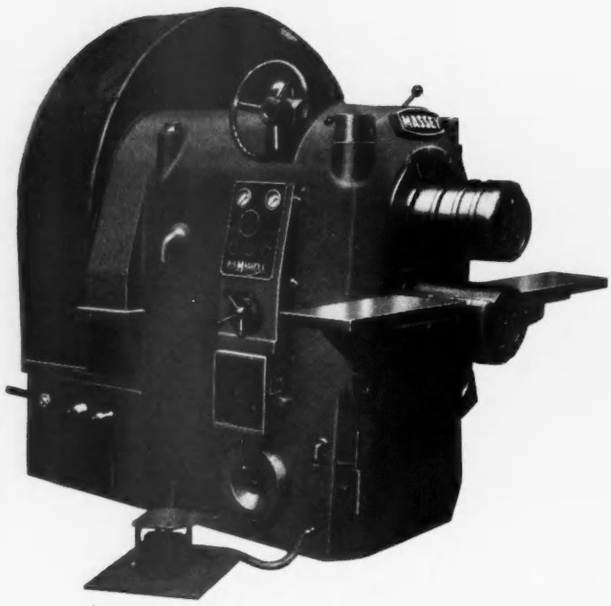
WITH MASSEY USE-ROLLERS



Rolling is now accepted as an excellent method, quick and cheap, of preparing material for drop forging, particularly in the case of long, thin, uses. Rolled uses cut out fullering, edging or forming and are clean, descaled and without flash. The material is accurately distributed, no operating skill is required, and time, labour and material are saved. The machine is portable, needing no permanent mounting or foundation and can therefore be placed just where it is wanted.

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- Automatic flood lubrication.
- Central panel provides quick and easy control of motor, single or continuous action, and over-run adjustment.

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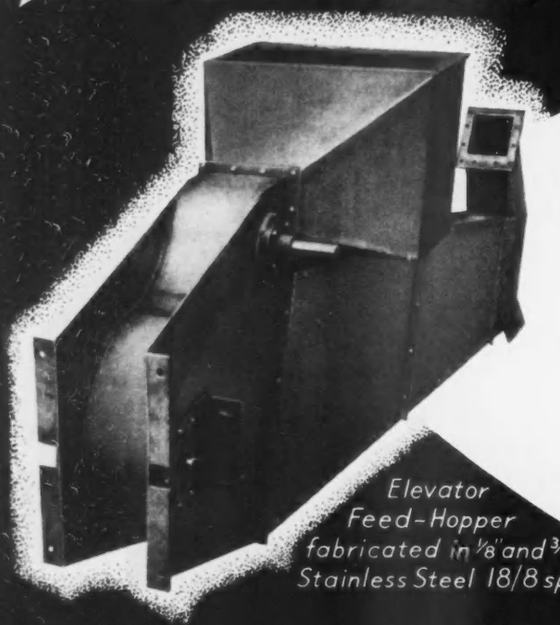

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Long experience and extensive development bring to machine designers and users in this new equipment all the features of electronic drives in a simple compact easy-to-use form at an economic price.

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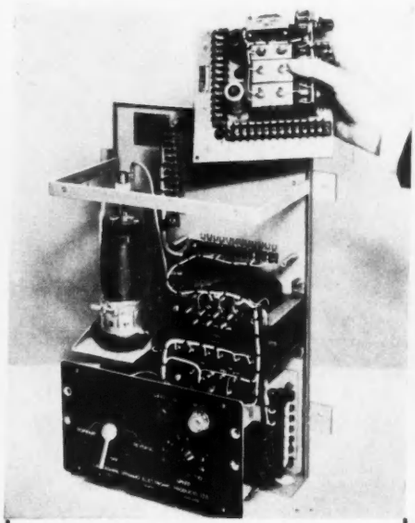
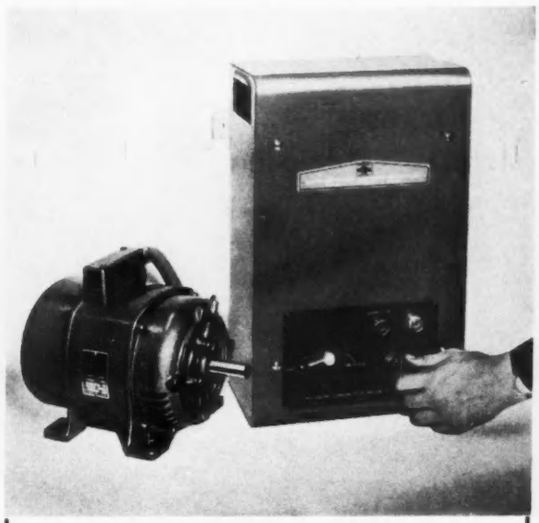
EASY TO INSTAL, just connect the a.c. supply and the motor—low in installation as well as first cost.

SMALL IN SIZE, (19¼" x 12¼" x 6½") and light in weight, the units open new possibilities for built-in machine drives, using versions available without the enclosing cover for such requirements.

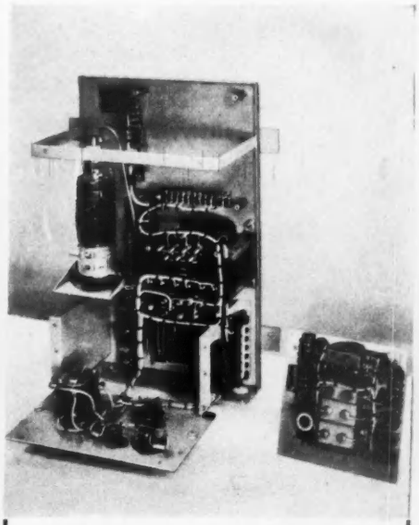
This new self-contained, high performance adjustable speed drive is the latest addition to Britain's widest range of electronic equipment, which includes the most comprehensive selection of specialised drives for every type of application — multi-motor speed matching, very high accuracy speed regulation, tension control, reeling and coiling and many others where controlled adjustable speed is needed.



UNIT CONSTRUCTION for economy and ease of maintenance. One control unit, easily removable with a screwdriver, is used in all ratings.



FINGERTIP SPEED ADJUSTMENT accurately sets speed despite load changes. Compact control panel provides for starting and reversing as well as speed setting.



COMPACT — YET FULLY ACCESSIBLE, the flat back wall mounting design and hinge forward control panel enable all components to be reached without difficulty.

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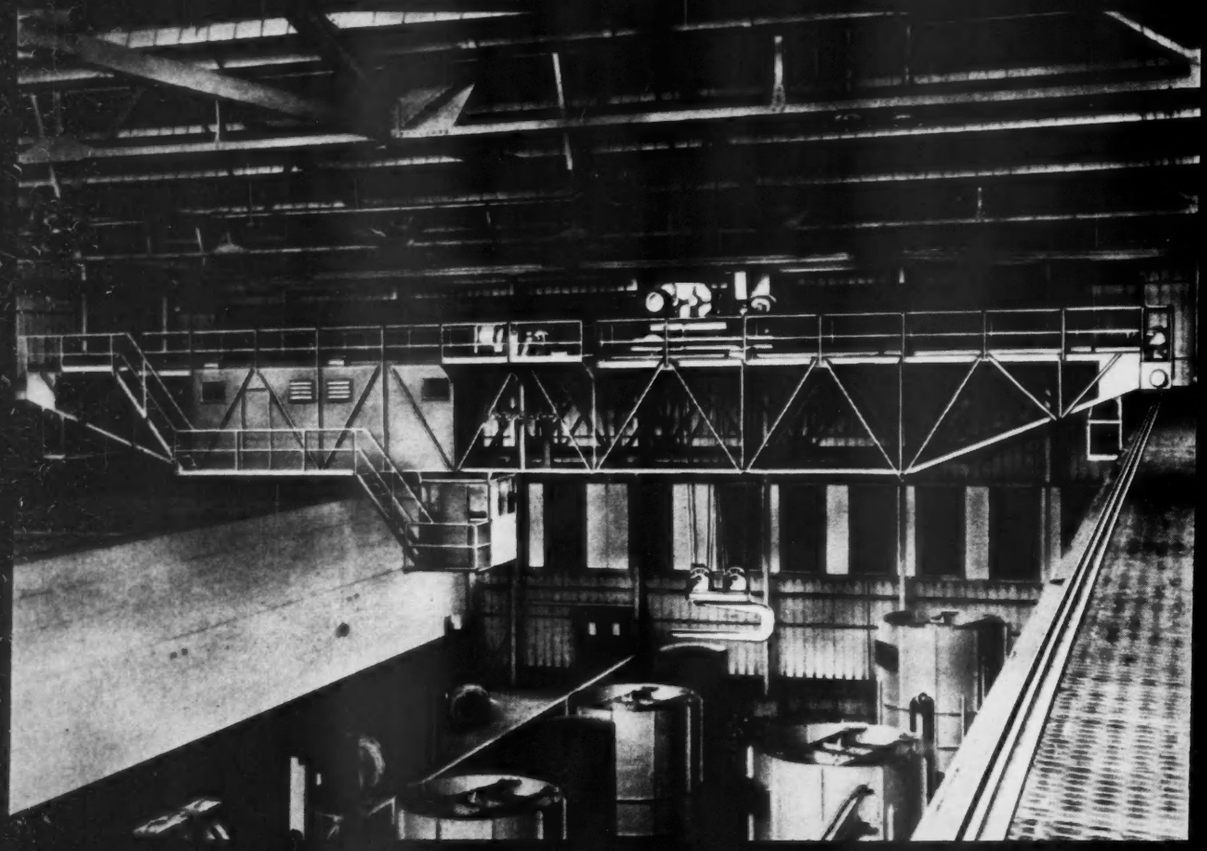

Working under almost every Service Condition conceivable is found the "John Smith" Electric Overhead Crane, doing its job efficiently, and earning the confidence of all users.

Some are fitted with Grabs, some with Magnets and some with special lifting equipment as shown in the illustration.

This particular unit is contactor controlled, with the contactor equipment house built into one of the Crane span girders.

If you have a lifting problem consult

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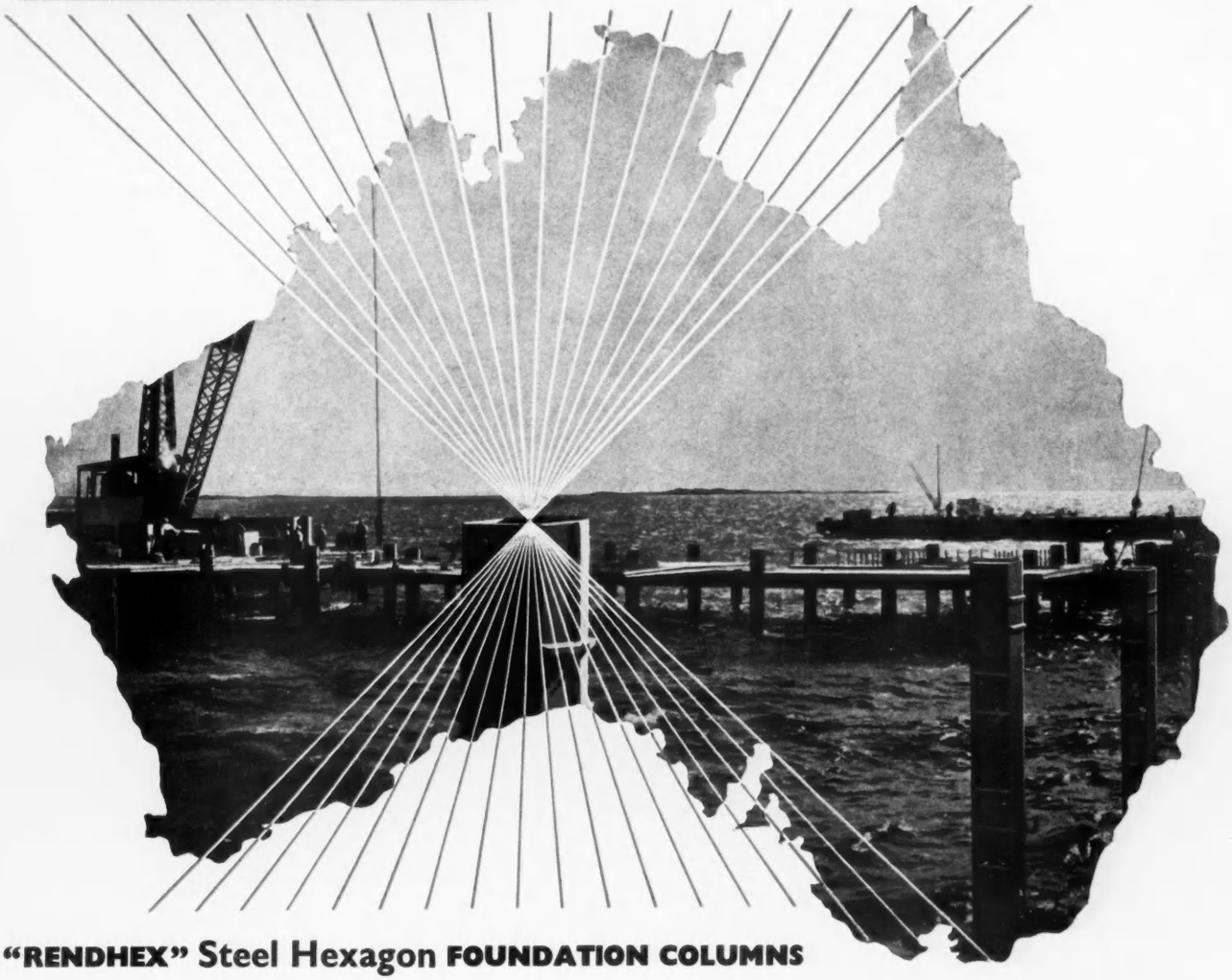
South Durham in AUSTRALIA



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South Durham "Rendhex" Foundation Columns form the sub-structure for the jetties. Constructed by welding two semi-hexagonal rolled steel sections together along specially designed joints, the columns represent a major advance in dock and harbour constructional practice.

In relation to their great strength and load-bearing capacity they are light in weight, easy to handle and economical in shipping and storage space. They can be supplied in long lengths which, by eliminating the necessity for jointing and fishplating, offer the maximum resistance to corrosion.

South Durham "Rendhex" Foundation Columns are available in three sizes: No. 3 (Light), No. 4 (Medium) and No. 6 (Heavy).

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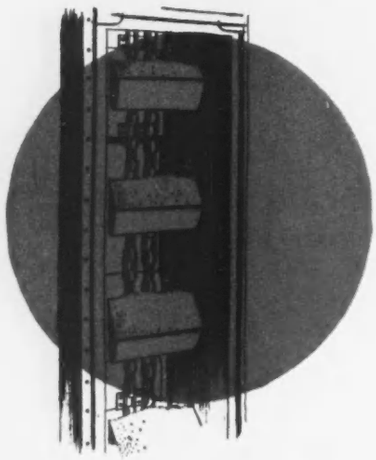

With their all-steel construction, accuracy of manufacture, and high ratio of strength to weight, they are the hallmark of a first class conveyor installation. These features mean least power consumption for the load moved, and the avoidance of excessive weight in conveyor structures.

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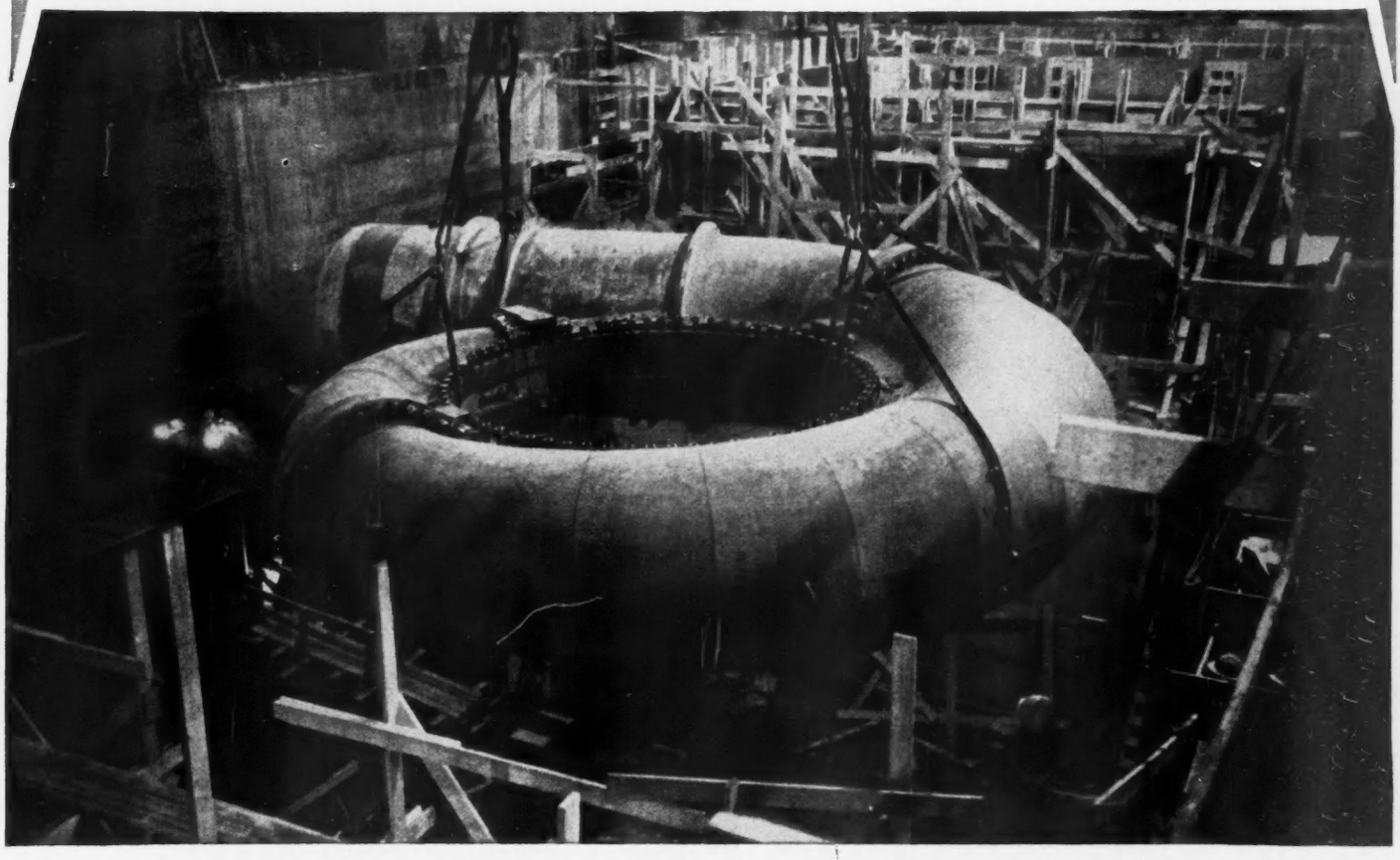

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At Hydro Quebec's Bersimis-Lac Casse Development in Canada, four 'ENGLISH ELECTRIC' water turbines have regularly supplied 520,000 kW to Quebec's power system from one of the world's most powerful hydro-electric stations. On occasions 200,000 h.p. has been developed from a single turbine under a net head of 840 feet.

This establishes a world record for hydro-electric units, being more than 10% greater than the output of any other high head turbine. These turbines of 'ENGLISH ELECTRIC' design were supplied by English Electric Company of Canada Limited, and were manufactured at the John Inglis Co. Limited plants in Toronto.

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There's no magic about Sykes Dewatering Equipment. Its efficiency is due to excellent design backed by 100 years of pumping experience. In the same way there is no mystery about installing and operating the system. The remarkable jetting efficiency of the unique Jętwell wellpoints makes installation simple, speedy and economical. Reliability of operation is so high that the plant can be maintained by one semi-skilled man, and will give non-stop service for months on end with the very minimum of attention.

The photograph shows part of an excavation in water-bearing sand, taken to 25 ft below standing water level. This work was carried out by a contractor who had not previously owned dewatering equipment, and without expert assistance.

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ECONOMY

is the key-note . . .

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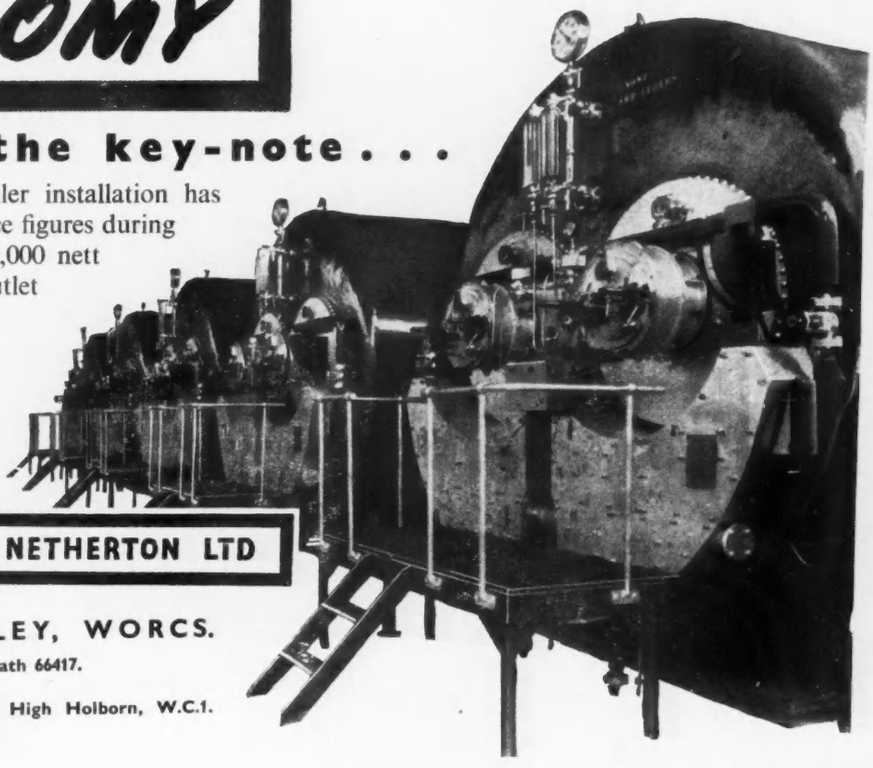
Nightingale Road Factory, Derby. Photograph by courtesy of Rolls Royce Ltd.



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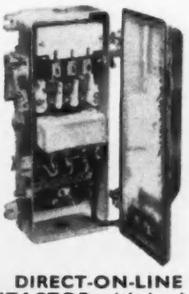

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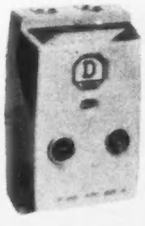

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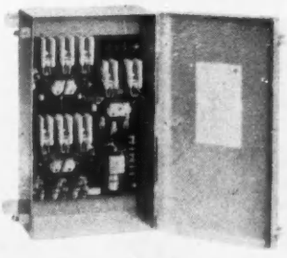

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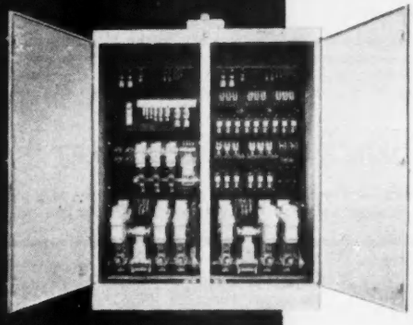

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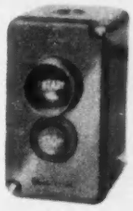

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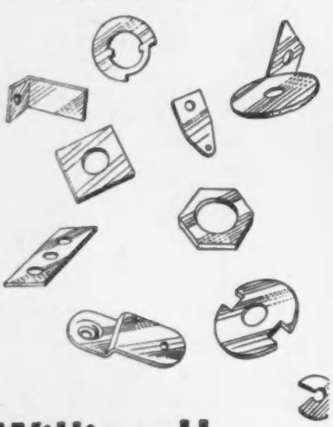

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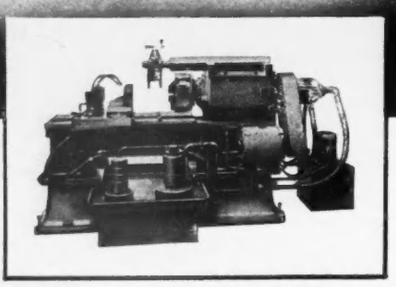

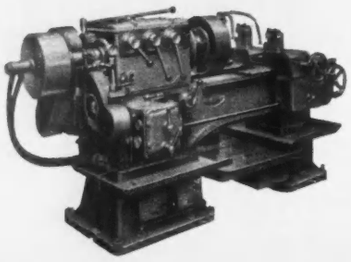

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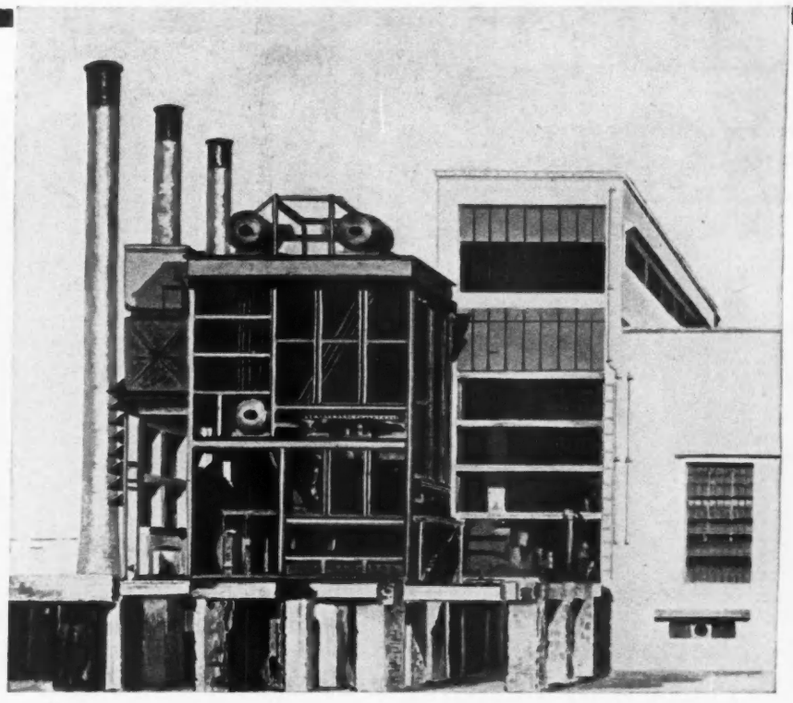

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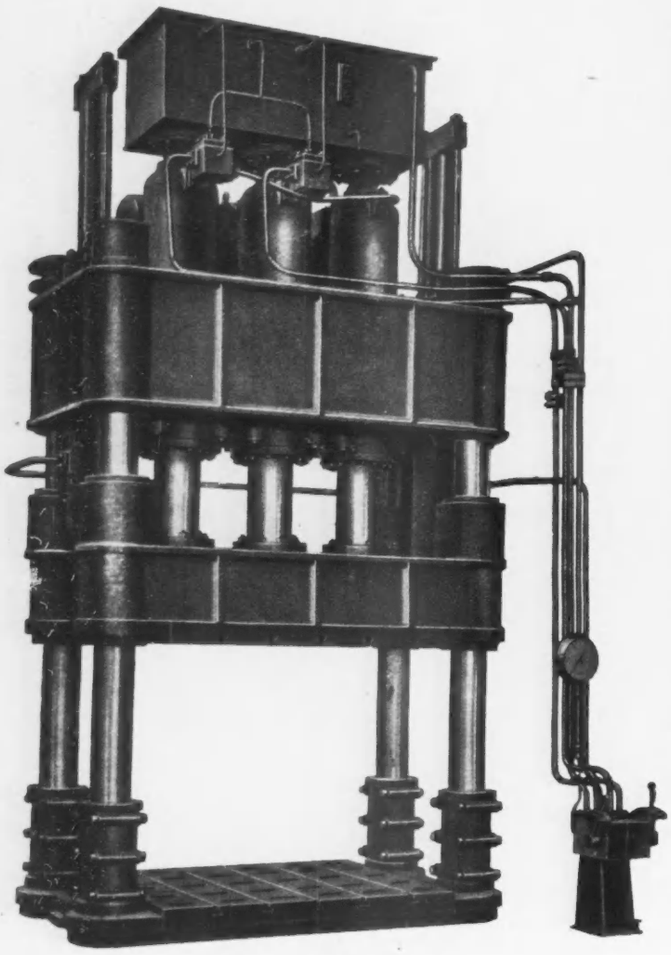

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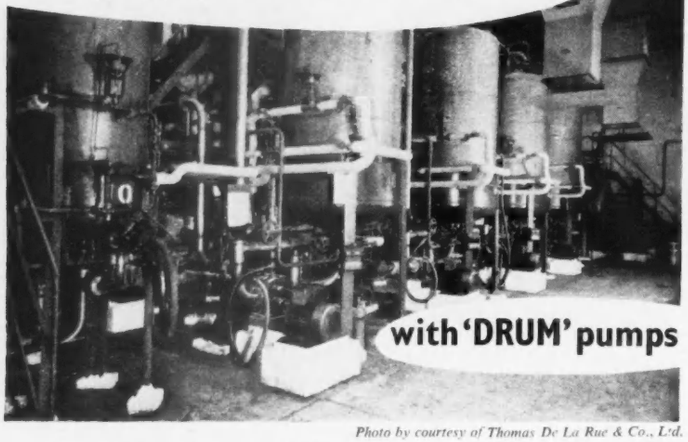

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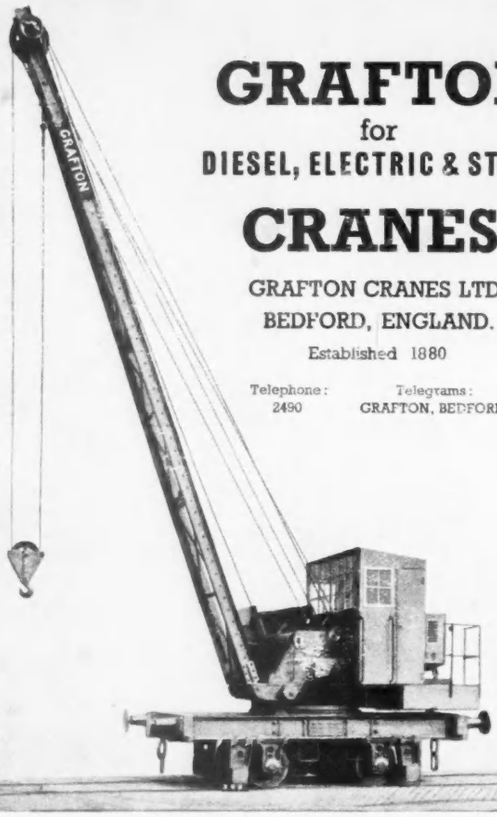

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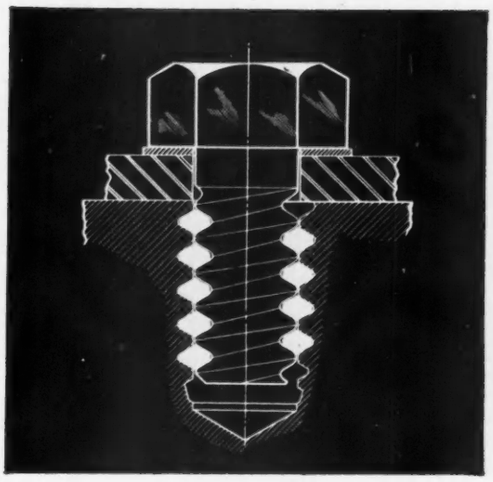

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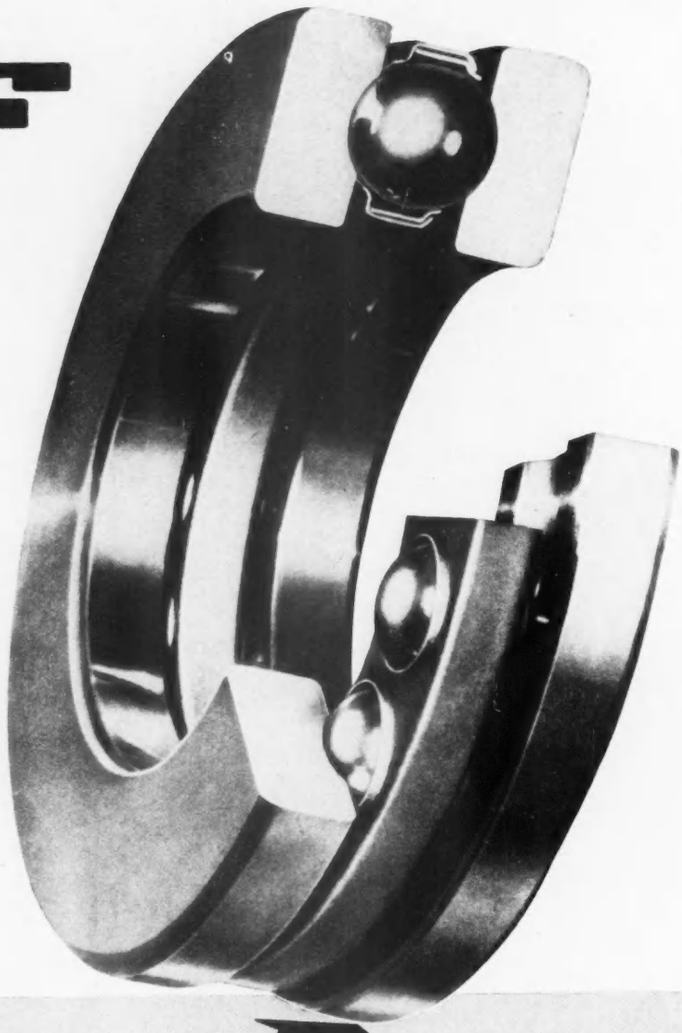

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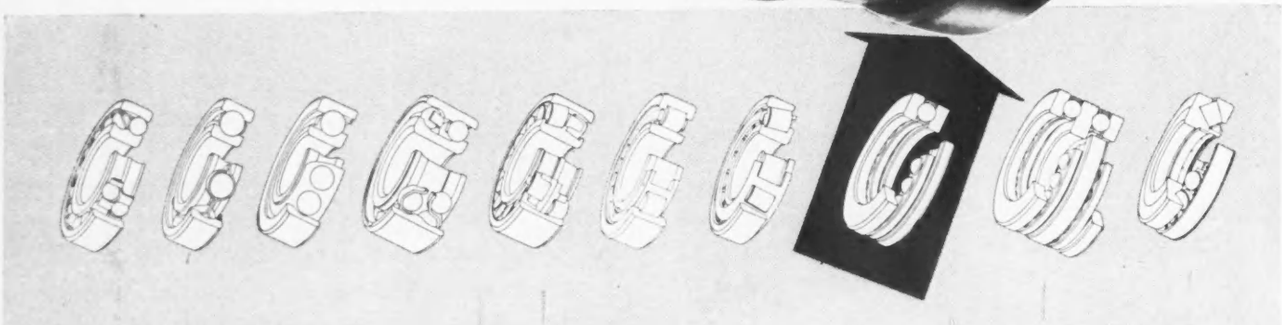

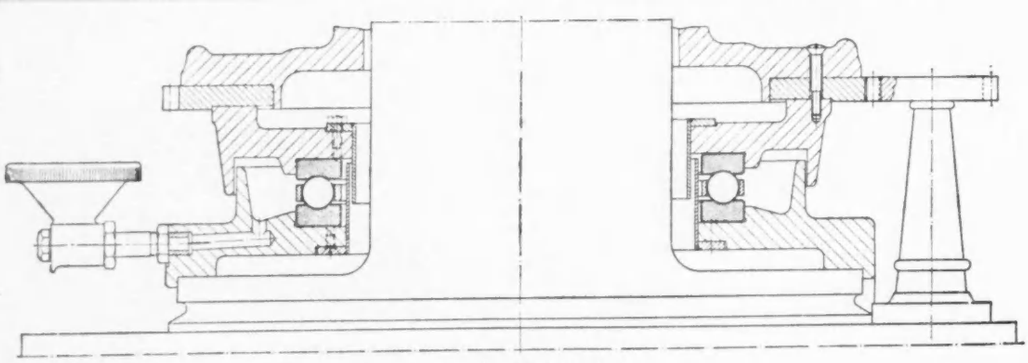

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THE ENGINEER

No. 5360 **OCTOBER 17, 1958** VOL. 206

A SHOT AT THE MOON

About a month ago the Americans fired a rocket in the hope of establishing a small body in an orbit around the moon. But there was a failure at a relatively low altitude and the rocket fell in the sea. It was expected that early this month, conditions being once more favourable, they would try again, and last Saturday night the news was received in this country that a rocket with an initial weight of 52 tons had been fired, that all its stages had functioned properly and that an object carrying about 40 lb of instruments was at that time travelling outwards towards the orbit of the moon. Temporarily there was substantial hope that the object would pass close to the moon, and it was planned that when it did a number of " vernier " rockets within it should be set off to decelerate it and thus permit the moon to capture it as a satellite. However, it was very soon observed that the object was departing from the required trajectory and measurement showed that it was travelling at, marginally, too low a velocity. This departure from plan, according to official reports, could be traced to some failure of directional guidance in the first stage which allowed the first part of the rocket's flight to diverge 3½ deg. from the desired direction. The ascent of the rocket through the atmosphere is said to have been steeper than planned with the consequence that the minimum speed of 23,870 miles per hour was not reached, though only by a matter of a few hundreds of miles per hour. Consequently, though the object reached some 79,200 miles out into space from the earth it never came at all close to the moon, which is some 238,860 miles away. This by about 165,000 miles may seem very large. In fact, in terms of the velocities involved, it is tiny.

As it happens, it is unlikely, even had there been no error in the launching angle, that the object could have been made to circumnavigate the moon. For when it was appreciated that the object could not reach the moon, but was travelling along a highly eccentric orbit about the earth (to which it was therefore bound to return), the decision was made to fire the remaining rockets at a suitable moment. The purpose was to establish the object permanently in an eccentric orbit with a perihelion far above the earth's atmosphere. But the rockets failed to operate. It is believed they failed to operate because the batteries to provide the power to fire the rockets upon receipt of a signal from the earth were chilled by unexpectedly low temperatures within the instrument case, so that the mechanism was no longer responsive to the signals. A lesson that will need to be applied when further attempts are made has therefore been learnt. As a consequence of the failure to fire these auxiliary rockets the object could not have been established in an orbit around the moon, even had it travelled the necessary distance from the earth. In fact, it followed an orbit which brought it back into the earth's atmosphere. Its existence is believed to have ended in a flash of flame high up above the South Pacific ocean on Monday night. In its brief life the object was able to signal back to earth certain valuable data about conditions in space and particularly about the heavy radiation belt discovered by the " Explorer " satellites. It may well be that this information will prove at least as scientifically valuable as any that could have been provided about the surface of the moon.

So there has been another failure ! Yet, in fact, success would have been very surprising. In attempting at the present stage of rocket development to reach the moon rocket designers are pressing everything to the limit. The velocity necessary to carry an object as far out into space as the moon approximates closely to that needed to fling an object clear off the earth upon a hyperbolic orbit. The attainment of that velocity even for an instrument payload as low as 40 lb is only just within the limits of the possible. The consequence is that the room for error at any stage in the launching of a suitable object must be almost nil, because insufficient power is available to correct the course after launching. Far, therefore, from commiserating with the Americans upon their failure, we congratulate them on the remarkable degree of success attained. By flinging an object nearly 80,000 miles out into space they have made more progress towards the objective of exploring the moon than anyone would have deemed possible only eighteen months or so ago.

AN ADDITIONAL USE FOR THE " ARROW " ?

Of the members of the Royal Aeronautical Society who gathered last week to hear the British Commonwealth lecture on the design and development of a supersonic military aircraft, many must have been opposite numbers of Mr. Floyd, of Canada, in the British firms of the Hawker Siddeley Group, who have twice been deprived of the opportunity to fly such a machine. Their interest in the lecture could be taken for granted. But the address must also have been of particular value to those charged with the procurement of equipment for the fighting services in this country. For a pronouncement of harsh realism was included in the preliminary discussion of the Royal Canadian Air Force requirements : " The decision was taken to design, develop and produce in Canada. This decision was not taken on the basis that there happened to be an established aircraft industry in Canada, although this obviously had some influence on the decision. However, the Chief of the Air Staff at that time, Air Marshal Slemon, made it quite clear that Canada was not in a position to undertake the development of a new aircraft if a suitable type was being designed, developed or produced in either the United States or the United Kingdom. . . ." That the Canadians not only saw the situation clearly, but matched their actions to their thoughts, is evidenced by their accomplishment, the Avro " Arrow." Particularly noteworthy is the magnitude of the step forward between the CF-100 all-weather fighter

and its planned successor, the CF-105, which will be apparent from the photograph reproduced on page 612. Even in the United States of America the realisation that often aeronautical progress can satisfactorily be made only in large strides is comparatively recent. The story of the development of our own fighter aircraft does not reflect the acquirement of a similar philosophy : a particularly clear, but not misleading, example to the contrary is provided by the succession of " Sea Vampire " by " Sea Venom " by " Sea Vixen," when set against a time scale on which such milestones as the passing over of the " Skylancer " are marked. The essential difference between the discontinuous and the progressive mode of advance is easily discerned ; for the " Arrow " is in flight before any other known machine that could play the same part in its weapons system, even though the first few machines have been twice redesigned to suit different engines.

It is no new finding that a really up-to-date military aircraft will, in all probability, prove supreme in roles other than that for which it was originally designed. Yet the state that the development of one single aircraft project can absorb a quite substantial fraction of a nation's military budget has lent a new urgency to exploiting this finding. Canada, however, is in the distinctive position that her " chosen role in military air power is one of defence, and Canada does not maintain any bombing or tactical air force," and so it is not yet determined, nor will it be until next March, that production quantities of the " Arrow " will be ordered ; for Canada is very near to one of the only two nations with operational long-range anti-aircraft missiles, which might make manned fighter aircraft obsolete. But for Britain, whose role is to be offensive as well as defensive, there is already an urgent need for an aircraft to penetrate hostile air space at great speed, for how else than by reconnaissance are we to find targets for our promised missiles, or to know whether we have hit them ? Yet there does not appear to be even a design in being for such an aircraft. When it is appreciated that the designers of the " Arrow " have provided for even more tankage than their long range interception mission demands, and when it is borne in mind that the " buddy " system of flight refuelling (in which the tanker is another aircraft of the same design, adapted to transfer fuel from its tanks to a trailing drogue) can add more than a third to the range of an aircraft, and when it is further observed that the war load of the " Arrow " is concentrated in a removable pack, it seems a sensible suggestion that the Royal Air Force could and should share in the privilege of using what may well prove to be the ultimate in light alloy aeroplanes. Whether the CF-105 will meet the recently prepared operational requirement 339 which presumably is for an aircraft to be delivered long after 1961, it would be profitless to guess, but if operation from no or poor runways is involved it will not. However, there is a contemporary reason why it is in the interests of Great Britain as well as Canada that the utmost use should be made of this challenging aircraft. Up till now this country has attempted to develop and manufacture native aircraft to meet all its military requirements, whether or not these requirements were parallel to those of other nations. That policy has, we believe, benefited the aircraft industry and the nation. However, as the money available to devote to development is limited and as sometimes the development of a single " wrong horse " (or what a Ministry comes to believe to be a " wrong horse ") may be pursued to the exclusion of all others, there are likely to occur periods when in certain sectors our defence requirements do not appear capable of being met from home sources within a reasonable period. It then becomes good sense to import a limited number of machines for certain missions not peculiar to the Royal Air Force. It might, therefore, in the present circumstances prove sound economically as well as militarily for the Ministry of Supply to announce the interest of this nation in the Avro " Arrow," a machine which the Hawker Siddeley Group has already designed and developed and the first examples of which have been built on production tooling so that supplies would be almost immediately available were an order placed.

BRITISH STEEL

The latest production statement issued by the Iron and Steel Board shows some increase in steel output following the two holiday months of July and August. But it shows also that this year's production is now some distance below that which has been achieved in the last three years. In the nine months ended September, the weekly average production of steel was 378,800 tons, which means that output has been running at an annual rate of 19,700,000 tons. In the comparable period of last year, the annual rate was 21,602,000 tons. The industry has capacity available for a steel output this year of at least 23,000,000 tons, but the final result of the complete year's operations will obviously fall a good deal short of that amount. The changes in the economic climate over the past twelve months are responsible for this setback in the activity of an industry which in the post-war years has been working at full throttle to meet the demands made upon it. Up till a few months ago, steel of many descriptions was in short supply despite an ever-increasing production. Now, however, for the present, the demand has lessened. The pause in capital investment which was initiated just over a year ago, and the reduced pace of industrial activity generally, have created what has recently been described as a " cold wind blowing through the steel industry." Happily, that touch of cold wind is a long way from a state of gale force, and it is reasonable to hope that the pause in the growth of industrial production and investment which this country—in common with other countries—has been compelled to endure will be no more than a temporary phase. That is the view wisely taken by the Iron and Steel Board and, we believe, by the great industry of which the Board has oversight. The declining demand for British steel is certainly not a pleasant circumstance for the national economy, but it is proper to consider it, as the Board does, as " in the nature of a short term influence." Accordingly, there is little if any slackening in the big development and modernisation projects which the steel companies have in hand. One recent outstanding example of these projects, the universal beam mill on the North East coast, is described elsewhere in this issue. The investment of money and technical skill in this and other development schemes which are in progress is sound evidence of the British steel industry's confidence in its future.

BULLOCK POWER IN INDIA

On page 620 towards the back of this issue there will be found an illustrated description by our Indian correspondent of a gear by which water can be pumped and electricity generated by bullock power. The device harks back to the medieval circular walkway for a horse or other animal driving machinery. But in this modern version chain gearing is employed to increase the two revolutions per minute of bullocks around the walkway to 150 r.p.m.

at a pump and 1320 r.p.m. at an electric generator. The cost of installing the gear at an Indian village is stated to be about £1875 against some £4500 (supposing spare power to be available) for connecting up a village to the electricity grid. At first glance that seems to provide sufficient economic justification for the supply of plants to a high proportion of the 550,000 odd villages in India of which only some 20,000 have so far been electrified. But we cannot help wondering about the true economics of the proposal. For it is certainly rather startling to have it suggested that animal muscle power can compete economically with power generated from fossil or other fuels in India—or anywhere else. That is a proposition which has been untrue in this country since at least the days of Watt. No doubt it may be true in large areas of India simply because no fossil or other satisfactory fuel is or can be made cheaply available. The fact also brings sharply home to us how low must be the living standards in the majority of Indian villages. For until electricity can be brought in the power available to the inhabitants is limited to that of the number of bullocks which can be supported by the land. Nor will the adoption of the gear described by our correspondent bring about any change in that relationship though it may possibly be true, of course, that by use of the gear the bullock power will be the more efficiently applied. Yet we wonder if it can be so. For in relation to the food resources available for man and beast the cost of bullock-generated power may prove too high. After all the number of bullocks around a village cannot be increased so that those which drive the gear must be diverted from some other task. However, it is of course possible that much bullock-time is in any case idle. It will be interesting to see. Meanwhile it is worth repeating a striking statistic mentioned by our correspondent. The combined power potential of the bullock population of India is probably greater than the installed capacity of public utility undertakings in the U.S.A.—124 million kW—and far, far, exceeds India's installed capacity of 3,500,000kW of electric power.

IDEAS AFTER DINNER

It is very seldom that we listen to speakers, even after-dinner speakers, without hearing at least one remark which triggers off certain speculations or opens up some prospect to view that we had not appreciated existed. In Glasgow last week at the James Watt dinner of the Institution of Engineers and Shipbuilders in Scotland, held in St. Andrews Halls on Thursday, October 9, several such remarks were made. Of course, not all the remarks that so attract our attention have any real novelty. Much more frequently it is a trick of expression which is involved. Yet when Sir Edward Appleton, at that dinner, remarked that he did not care much for the expression so often used in industrial negotiations " both sides of industry," and that he thought the term " both arms of industry " was better, he was pointing out what is often forgotten in the irritation of negotiating upon a wage claim, that industry operates by the co-operation of management and men not through any conflict between them. We often think that trades unions are at fault in not impressing the point more firmly on their members. For every so often, within a works or upon a civil engineering site, the men allow leaders to take charge of them who clearly believe in " sides " rather than " arms," with disastrous results upon efficiency.

Another of Sir Edward's remarks seemed truthful enough at the time of its delivery. It was, if we understood him aright, that nowadays so many improvements in industry are rooted in the application of scientific discovery that there is less need than there was for the intuitive inventor. Yet the more we reflect upon this expression of opinion the less sure we become of its rightness. We do not dispute Sir Edward's premise. But we think he may be under-estimating what it is that an engineer does in converting a laboratory process into a practical device usable by industry or by a lay purchaser. For certainly there are important stages in the process which are both intuitive and inventive. We rather doubt whether it makes much difference to the inventive process whether the starting point is a collection of observed practical facts or a theory based on the results of scientifically conducted experiments. The engineer still has to have the imagination to see how the information might be applied and the inventiveness to find the means of applying it. Is there not a confusion in Sir Edward's remark between the roots from which an inventor draws inspiration and the quite separate intuitive act of invention itself ? Were the engineers of a century ago really more inventive than those living to-day ? We think the achievements of engineers in the last decade or so belie any such suggestion. But there ! The art of after-dinner speaking, already in decline, would receive its death-knell if its exponents had deeply and seriously to think out all the implications which might be read into their lightest words.

The Engineer— 100 Years Ago (OCTOBER 15, 1858)

" FIREPROOF STEAMSHIPS."

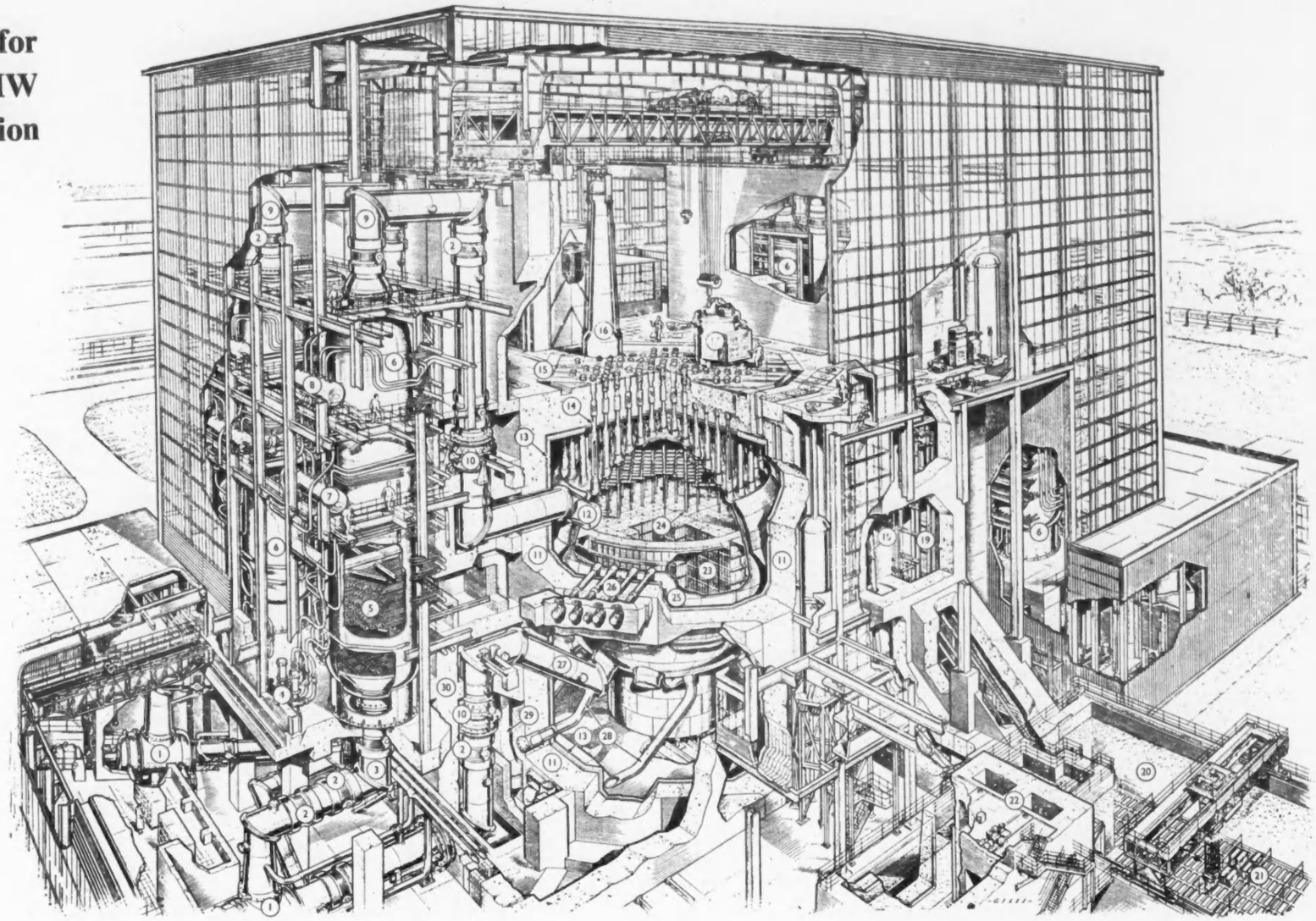
" Were a Clyde builder to receive an order for a fireproof ship, we have no doubt he would ask ' What next ? ' Certain materials, in themselves fireproof, are indeed already used in the construction of ships, but not at all, as we believe, because they are fireproof. When the Dublin Steam Packet Company decided, some thirty years ago, to build the first iron steamship, the Garryowen, nothing was said of increased security from fire. For it was well known that a wooden hull only burns to the water's edge after all within has met the flames.

" Yet an order for a ship, practically fireproof, at least to the full protection of life from fire, would involve no practical difficulties in its execution, nor do we suppose that it would involve any considerable increase of cost. When wanted, the ship would be forthcoming as much as if it had been a Chubb safe or a powder magazine. To shut up a fire in any compartment in which it might originate, and to let in sea water, if necessary, for its extinction, would be perfectly practicable, and a very little thought would show how every passenger could be safely removed to another part of the ship, altogether out of the reach of fire. When vessels like the Austria are burned, under the most appalling circumstances, and only from a quantity of tar being spilled upon a heated iron, it is a terrible reproach upon our resources of preservation. On ordinary steamers we cannot look among the passengers for the coolness and discipline by which the troops on board the Sarah Sands conquered a fire which had gained full headway in that vessel. The possibility of such conflagrations must be entirely prevented .... We should not be surprised if the Dublin Steam Packet Company, which first adopted watertight compartments, should be the first also to produce a fireproof steamer. In the meantime, no other company nor any shipbuilder need hesitate to compete for this lasting honour."

Reactor Building for Hinkley Point 500MW Nuclear Power Station

This drawing is reproduced from THE ENGINEER, March 14, 1958, page 402.

1—Coolant gas circulating blowers.
2—Hinged expansion bellows.
3—Coolant gas outlet from steam-raising unit.
4—Steam-raising-unit circulating pumps.
5—Stud tube elements.
6—Steam-raising units (six per reactor).
7—Low-pressure steam drum.
8—High-pressure steam drum.
9—Coolant gas inlet to steam-raising unit.
10—Coolant gas isolating valves.
11—Main biological shield.
12—Coolant gas outlet from reactor.
13—Thermal shield.
14—Charge tubes.
15—Charge floor.
16—Hole-preparation machine.
17—Charge and discharge machine.
18—Emergency discharge chute.
19—Spent fuel element skip hoist.
20—Cooling pond.
21—Storage skips and grid.
22—Skip loading bays.
23—Graphite moderator core.
24—Control rod.
25—Reactor pressure vessel.
26—Can failure detection standpipes.
27—Coolant gas inlet to reactor.
28—Debris-removal ducts.
29—Shield cooling air ducting.
30—Secondary biological shield.



Hinkley Point Nuclear Power Station

*The design of Hinkley Point power station was the subject of a paper by Dr. H. S. Arms, C. Bottrell and P. H. W. Wolff * at the "Atoms for Peace" Conference at Geneva last month. Abstracts from this paper are reproduced here, accompanied by a number of illustrations and a brief progress report gleaned from a recent visit to the site. Hinkley Point, the fourth of the British nuclear power stations to be ordered, will have two gas-cooled graphite-moderated reactors, with a net electrical output of 500MW, an efficiency of 26 per cent and anticipated generation costs of less than 0·65d. per unit sent out.*

MOST of the conditions considered necessary for the site of a nuclear power station are fulfilled at Hinkley Point, on the south side of the Bristol Channel, about 8 miles north-west of Bridgwater, Somerset. The site is relatively near to an area with a high load demand where generation with coal is costly because of distance from coalfields. It provides good foundation conditions and has an adequate supply of cooling water from the sea. Further, it is in a region of low population density, in accordance with the current practice of siting these stations away from densely populated areas until more experience of operation has been obtained. In addition, the land is not particularly good for agriculture nor is it a particular beauty spot.

The formation is part of the Lower Lias limestones and shales overlaid in parts by a surface deposit of brown clay ranging in thickness from zero to about 6ft. In general, the bearing capacity is of the order of 10 tons per square foot. Settlement is expected to be negligible. The site slopes gently towards the sea and it has been necessary to excavate about 175,000 yards of material. A sea wall some 1000 yards long between existing coast protection works on the east and a low cliff on the west will reclaim part of the foreshore and help to balance cut and fill, as well as providing protection from the sea and a site for the turbine house and pump house.

The station layout was determined basically from consideration of economy, ease of operation, ease of control, safety, and ease of construction. The turbine house is arranged nearly parallel with the sea wall and parallel with the line connecting the centres of the two reactors which are on the landward side of the site. This disposition requires the minimum length and expense for the cooling water culverts, though it does require a fairly long run of cable to reach the switch yard behind the reactors.

The arrangement of the reactor buildings, each with three boilers and associated blower houses on either side, and their orientation with respect to the turbine house was determined, partly from reasons of economy of pipe and cable runs, but largely by the decision to use a Goliath crane for erection of the heat exchanger shells and the pressure vessel sections. This Goliath crane will have a span of 250ft and a clear height of 210ft with a lifting capacity of 400 tons on the main hooks and will be able to span each reactor and its associated building in turn. The boiler shells and pressure vessel sections will be fabricated in a specially constructed shop to the west of the reactors and brought to position by the crane. A group of administration buildings were located at the eastern end of the turbine house to allow construction to begin from that end and to allow expansion of some of the buildings as and when a second station is built to the east of the present one. The fuel cooling ponds, decontamination area, laundry, and effluent treatment plant are placed on the south side of the reactors to isolate these areas as much as possible from the rest of the site and to make the access for bringing in and removing fuel as direct as possible.

The general layout of the reactor buildings and associated equipment is shown in the drawing. Three boilers and their associated ducts and carbon dioxide blowers are located on the east and west sides of each reactor. On the north side of each reactor is an auxiliary building housing the bulk of the equipment needed for CO_2 storage, vacuum systems, flux measurement, electrical supply, control rod power supply, fuel element failure detection, and shield cooling. The equipment on the south side of each reactor includes a test facility for the fuelling and hole preparation machines, discharge arrangements for spent fuel and an access shaft to allow heavy equipment to be lowered from pile cap to ground level. At pile cap level the space is largely devoted to fuelling and servicing operations on the reactor. The crane provided, of 150 tons capacity, is an integral part of the fuelling and servicing equipment.

Each reactor building is 175ft high by 345ft by 185ft in plan.

Main Parameters of Hinkley Point Nuclear Power Station

Reactor :	
Number of reactors per station	Two
Reactor heat rating	966MW
Diameter of pressure vessel	67ft
Thickness of pressure vessel (excluding internal insulation)	3in
Coolant	CO_2
Nominal maximum can temperature	430 deg. Cent.
Reactor inlet temperature	178·9 deg. Cent. (354 deg. Fah.)
Reactor bulked outlet temperature	373·3 deg. Cent. (704 deg. Fah.)
Reactor inlet pressure	185 lb/sq. in gauge
Reactor gas mass flow	10,300 lb per second
Total reactor pressure drop	4·45 lb/sq. in
Total gas circuit pressure drop	8·63 lb/sq. in
Boilers and Turbines :	
Number of steam raising units	Twelve
H.P. steam pressure at superheater outlet	640 lb/sq. in gauge
H.P. steam temperature at superheater outlet	685 deg. Fah.
L.P. steam pressure at superheater outlet	170 lb/sq. in gauge
L.P. steam temperature at superheater outlet	660 deg. Fah.
Total steam flow from S.R.U.s/reactor	$2·76 \times 10^6$ lb per hour
Total H.P. steam flow from S.R.U.s/reactor	$1·76 \times 10^6$ lb per hour
Total L.P. steam flow from S.R.U.s/reactor	$1·00 \times 10^6$ lb per hour
Number of main turbines	Six
Output of each turbine	87MW
Number of variable frequency turbines	Three
Load on variable frequency turbines/reactor	25·2MW
Heat transferred to gas by circulators/reactor	22·9MW
Maximum capability of each variable frequency turbine	33MW
Heat transferred from gas in boiler/reactor	986·2MW
Main Circulators :	
Number of circulators	Twelve
Type of circulator	Single stage axial
Blower temperature rise	5·0 deg. Cent.
Output :	
Net electrical output	500MW
Net efficiency	0·26

The Gas Circuit

The spherical pressure vessel is constructed of a boiler quality mild steel suitable for site fabrication and relatively immune to radiation damage. By a combination of internal insulation of the top of the vessel, external insulation of the bottom of the vessel and carefully designed air cooling arrangements, it is possible to maintain the vessel temperature everywhere between the temperatures of about 600 deg. and 650 deg. Fah. These temperatures are low enough to avoid the necessity of lowering stress levels to cater for possible creep and high enough to make any radiation damage self-annealing. As a consequence, it is possible to increase the gas pressure to 185 lb per square inch gauge, so that high rates of heat extraction from the fuel become economical.

The pressure vessel is designed with full-strength compensation on all its major openings by forged T-section rings butt-welded on to the plating so that full X-ray inspection can be done. At the top of the vessel approximately 200 standpipes are provided, one for each group of thirty-six fuel channels plus extras to carry control rods and flux scanning gear. Each of these standpipes enters the vessel through a compensating nozzle.

One of the major improvements in the Hinkley Point design has been the provision of an open Warren girder type of support structure to carry the graphite. This open structure passes the gas flow from the bottom ducts to the fuel channels with the consequent

* The English Electric–Babcock and Wilcox–Taylor Woodrow Atomic Power Group.

possibility of raising the graphite volume in the sphere to about 40 per cent of the whole volume of the sphere as compared with about 30 per cent in previous designs. This support structure and the sphere itself are carried on a skirt ring, relatively shallow inside the vessel and longer outside. The junction between the skirt and the sphere is subject to elastic distortion caused by the increase of the sphere diameter under inflation pressure, and increase of skirt diameter under axial gravity loading, as well as steady and transient thermal gradients. Although this type of support looks very simple, it will be appreciated that it requires very careful design. The important joint between the skirt and sphere consists of a forged ring butt-welded on to the plating. Insulation and fairing plates guard the junction against excessive thermal gradients. Since the insulation inside the top of the vessel cannot be serviced once the reactor is active, it is of extremely robust construction, of stainless steel sheet protected by ¼in mild steel plate on the gas side. Fortunately, the conductance needed, 2 B.Th.U. per square foot-hour per deg. Fah., is easy to obtain with a relatively thin pack.

A number of improvements have also been possible in the remainder of the gas circuit. The method of construction adopted, of using a Goliath crane which straddles the reactor buildings and which lifts complete boiler shells and pressure vessel sections into position, shortens appreciably the time which must be spent on construction and, hence, the cost of site labour. This method puts a premium on keeping the span of the buildings and of the row of boilers to a minimum and, hence, of developing the capacity of each boiler and each set of ducts to the maximum.

The boilers themselves are of the same general type as those used at Calder, but are much improved. In particular, the efficiency of space utilisation inside the shell is greatly improved by shaping the tube banks to fit closely to the shell and to the inspection passages. In addition, the detailed design of the studded tubes has given both greater heat transfer per foot run of tube and lower pressure loss per unit of heat transfer. The design is also helped in this respect by the higher CO_2 pressure. The volumetric heat rating is about twice that achieved at Calder, and this, combined with an increase in diameter to 21ft 6in and in height to 90ft, allows each boiler to handle over 160MW of heat compared to about 50MW each at Calder.

The method of construction of the boilers is the same as that adopted at Calder Hall. Complete rings and domes, fabricated at works, will be joined by circumferential welds in the special shop at site (illustrated opposite) to make the complete shell and after hydraulic pressure testing will be placed in position and fitted under rigorously clean conditions, with tubes, headers, drums and auxiliary equipment. The 21ft 6in diameter rings are too large for road or rail transport in Great Britain, so that they will be brought to site from Renfrew, Scotland, by sea, via a small harbour (Combwich Wharf), probably used by the Romans but long neglected, situated just off the main access road to the site. Brief details of the works at Combwich Wharf are given below.

The design of the ducting end of the blowers is relatively straightforward. The 6ft 6in diameter ducts in any one circuit are arranged to be co-planar to avoid the need for gimballed expansion joints. The joints are 5ft 6in diameter, internally joined to the ducts by venturi sections, as are the main gas valves of the butterfly type. The valves are located just outside the main biological shield and between the pressure vessel and expansion joints to provide for maintenance.

The CO_2 circulators are single-stage axial-flow fans with overhung rotors operating at nearly 3000 r.p.m. One special feature is the use of air-lubricated CO_2 packed shaft seals. Because of the high pressure level, the rotor and stator casings are contained in a cylindrical pressure vessel of about 13ft diameter.

Blower Drive

The method of blower drive is of special interest. As the heat output of a gas cooled reactor is varied, it is highly desirable to vary the gas flow in proportion. This will maintain all temperatures roughly at their full load value and thus give best part load efficiency, at the same time facilitating rapid load changes and minimising trouble from varying temperature gradients through the fuel and the reactor core. Many methods of varying the gas flow have been suggested, but only a few of these use well-tried equipment. Of the methods involving constant blower shaft speed, that of by-passing part of the flow back to the blower inlet is simplest and most reliable, but this shows worse part-load performance than the better type of systems for varying the shaft speed. The power required by each blower is about 5500 h.p. at design point, with 7000 h.p. provided for either overload capability or to provide against a short-fall in performance or possible long-term deterioration of the system. At this power, without using gearing, only direct steam turbine drive or squirrel-cage induction motors appeared suitable. On the grounds of providing the smallest probable maintenance outage, squirrel-cage motors were chosen and, since slipping couplings of proved reliability were not available for the power and speed required, variable frequency turbo-alternators were chosen to provide the power. Three of these variable frequency sets are provided so that a maintenance stand-by is available.

This scheme, though certainly not the cheapest, was selected as that involving the least technical uncertainty. The controlled speed range is from 750 to 3000 r.p.m., so that stiff shafts are required for the motor, turbine and alternator, as well as an independent drive for the alternator cooling fans.

The Reactor Core

The principal features of the core follow the lines laid down in the Calder design. The graphite blocks, about 30in long, are located laterally by the double-tile arrangement developed by the Atomic Energy Authority to provide for minimum Wigner growth in the vertical and two perpendicular horizontal directions. The general shape is a twenty-four-sided prism, carried on ball bearings, to cater for differential thermal expansion of the graphite and steel supporting structure. The tongue and groove keying system between bricks and tiles has been offset, however, to reduce gas leakage from the fuel channels, giving about a 2 per cent gain in reactor output. An incidental advantage of this change is a reduction of the bursting force exerted by the leakage gas, so that the duty of the restraint garters is eased. These garters, of co-axial mild and stainless steel tubes, follow the Calder design, but an additional swinging link which attaches the spring to the restraint beam makes the spring tensions automatically equalising and avoids distorting forces on the stack during tightening. Further, by the use of stops on the restraint beams limiting the movement of the swinging links, the system is so arranged that, if one of the twenty-four springs fails, the tension of the remaining twenty-three is transmitted through the appropriate beam.

The fuel element contains a cylindrical heat-treated uranium rod in a helically finned can provided with a side support to limit bow which would otherwise take place. The elements are stacked in the channels, and are handled from above for charge and discharge.

Fuelling Gear

In common with the other three commercial nuclear power stations at present being built in Great Britain, the Hinkley Point reactors will be refuelled while operating at full pressure and full load. The operation will be continuous rather than batchwise. The advantages of this system are obvious. Interest and amortisation charges alone on a 500MW station will amount to something like £15,000 a day. The difficulties are perhaps not so obvious. The equipment provided is essentially four main machines, a crane for moving the various items on the pile cap, a " hole preparation " machine for handling shield plugs or other equipment normally found in a pressure vessel standpipe, a charge chute for carrying the fuel from the pile cap to the core and back, and a fuelling machine to place and remove the individual fuel elements.

Some of the main considerations in the design of these machines are listed below.

The hole preparation machine and the fuelling machine with associated shielding each weighs about 140 tons and must be positioned to an accuracy of about ¼in on the pile cap floor.

A pressure-tight joint must be made between the machines and the reactor standpipes, capable of adjusting itself to care for thermal expansions of several inches, and of operating either cold or up to a few hundred deg. Fah.

The gas flow through a channel is upwards and it is easily shown that during fuelling operations the pressure drop available in a channel will be quite powerful enough to blow out the bottom one or two elements when the top ones are removed. To prevent this blowing out the maximum gas flow must be artificially restricted.

At operating temperature a fuel element is not strong enough to withstand the side forces which would be involved in dragging it around sharp corners. To avoid these forces, the charge chute is arranged to move radially with a parallel motion linkage which always holds the fuel element vertical. By a combination of this radial movement with movement in azimuth, it is possible to service thirty-six fuel channels from each stand pipe.

Reactor Control and Instrumentation

The control and instrumentation of the reactor generally follows well-established lines. The control rods themselves are clad boron steel tubes suspended by wire ropes from drums driven through a gearbox by a slow-speed synchronous motor supplied from a special variable-frequency power source, with arrangements for moving the rods either simultaneously or in groups. Near the periphery of the reactor one control rod for each thirty-six fuel channels is adequate and in this region the rods are carried from special standpipes at the corners of each six-by-six group of fuel channels. In the higher flux regions of the reactor, however, additional control is needed so that the extra rods are carried in the ordinary fuelling standpipes. The design of the motors and rods is such that they can be removed from or replaced in a running reactor by the hole preparation machine. If the power supply is cut from a

control rod motor the rod drops into the core under the action of gravity alone. The rod is, however, left connected to the motor, which acts as a generator and provides braking to regulate the speed of fall. The reactor instrumentation is conventional. Alarm and control rod trips are actuated by the usual signals, high flux level, short doubling time, excessive temperature of fuel element, gas or graphite, excessive rate of change of gas pressure or flow, or blower failure. Trip circuits are normally " two out of three " coincidence circuits. Flux is measured by high-level and low-level ion chambers in a thermal column built into the biological shield. Fuel element temperatures are measured by thermo-couples provided with spring-loaded contacts pressing against terminals of leads permanently embedded in the graphite structure. Trailing lead couples are provided for a small number of elements to provide a check on the behaviour of the embedded lead couples.

The fuel element can-failure detection equipment is of the standard type used at Calder, with the same sensitivity and operating times, but with an improved and more economical mechanical design, so arranged that it can be controlled from the central control room of the station.

Shielding

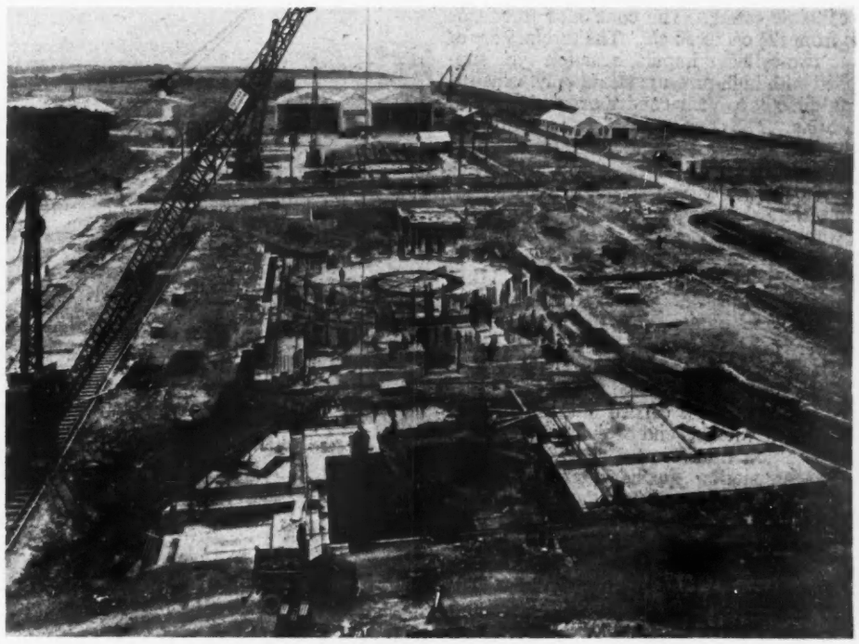
The shielding of mass concrete is divided into two sections, a monolithic main biological shield protected at duct and other openings by a thinner secondary shield. The thermal shield is of concrete as well, rather than of the more usual steel. The whole structure has been designed to comply with the most recent requirements of the International Committee for Radiological Protection with a substantial safety margin. The shielding is cooled by a relatively simple system of air passages associated with the same air flows and equipment that provides the cooling air for controlling the pressure vessel temperature. The shield cooling air, together with all the CO_2 which may be discharged from blowdown lines, relief valves, or leakage from fuelling machine connections, is filtered before being discharged at roof level.

Station Control and Reactor Safety

The main running controls for blower speed, control rod position, turbine throttle setting, and all important instrument readings are brought to a central station control room. Starting and supervision of plant is, however, to be carried out locally. The station is designed to be run with constant low-pressure and high-pressure steam pressures which will be maintained by manual adjustment of the main turbine governor settings. This greatly simplifies operating procedure and allows both reactors to be connected to a common steam range irrespective of their individual loads. Operating with a constant pressure of low-pressure steam will produce a change of reactor inlet gas temperature in sympathy with load changes, but the magnitude of this effect is not great enough to affect the permissible rate of change of load because of thermal stresses produced in the boilers or pressure vessel. To avoid the stresses which might otherwise occur when the reactor trips from a high load, the blowers are arranged to trip at the same time. To avoid the priming in the boiler which this might produce, a load limiting device is incorporated in the turbine governor to start closing the throttle if the steam pressure falls below 95 per cent of its design value. Simultaneous action of a feed regulator limits the supply of cold feed water to the boilers.

The safety of the reactors on shut-down is assured by two independent sources of power, a large battery and automatic-start diesel engines. Amongst other items of equipment these supply power to pony motors which automatically clutch in to drive the blowers at 10 per cent of full speed if the variable frequency power supply fails. A small d.c. boiler feed pump is automatically started to continue feed to the boilers. The same power sources also provide shut-down emergency power for the shield cooling fans and the fuelling machine cooling system.

In addition, the relative height of the thermal centres of the boilers and reactor ensure a natural convection flow of CO_2 large enough to remove fission product heating, and the water storage capacity of the boilers is large enough to absorb this heat for several hours even if no feed is available.



Hinkley Point site as seen towards the west from No. 1 reactor. In the centre are the foundations for No. 2 reactor. In the background is the site for the pressure vessel assembly building. Beyond that are buildings for fabricating steam raising units and for shot blasting

The Turbine House

The turbine house consists of a main hall 640ft long by 135ft wide and 90ft high, with a north annexe to house the main generator transformers, a south annexe to house the auxiliary switchgear, mechanical plant and tanks, and a workshop at the eastern end. The basement floor level is some 30ft below ground level so that the condensers are housed in the basement and the main operating floor is at ground level.

The six main turbo-alternators, each of 93·5MW maximum capacity, are arranged transversely, three at each end of the main hall, and the three variable frequency sets of 33MW maximum capacity each are also arranged transversely in the centre of the hall. The boiler feed pumps and the dump condenser plant are also located around the centre of the hall. A loading bay at each end caters for plant erection and subsequent maintenance. Two overhead travelling cranes provide lifts of 150 tons for the main hoist and 25 tons for the auxiliary hoist of one, and 40 tons for the main hoist and 15 tons for the auxiliary hoist of the other. The building is of structural steel framing with light-weight cladding.

Main Turbo-Generator Plant.—The main turbines are of the impulse reaction type operating on a dual-pressure cycle. At design rating the steam conditions at the turbine stop valve are :

	Pressure	Temperature
H.P.	615 lb/sq. in gauge	680 deg. Fah.
L.P.	150 lb/sq. in gauge	655 deg. Fah.
Vacuum ...	29in Hg	—
Final feed ...	—	166 deg. Fah.

The turbine has a single h.p. cylinder and two double flow l.p. cylinders solidly coupled in line, each double flow cylinder exhausting into its own condenser. The l.p. steam is admitted through a mixing belt about two-thirds of the way down the h.p. cylinder. The temperature of the l.p. steam is such as to provide some measure of reheat. The h.p. and l.p. steam is led to the turbine through four separately anchored combined stop and emergency valves, two for each pressure. The mechanical governor is driven from the h.p. shaft and is linked to oil pressure relays which operate controls on the h.p. and l.p. throttle valves. The gear associated with the h.p. valves is used for synchronising and for load control, while the gear associated with the l.p. valves controls the pressure of the l.p. steam. Two emergency governors fitted to the turbine shaft are arranged to shut both the h.p. and l.p. valves in the event of over speed. Vacuum and load limiting devices are arranged to unload the turbine in the event of deterioration of either vacuum or boiler pressure. The main oil pump which is driven from the end of the h.p. shaft furnishes oil both for the governor gear and lubrication. Auxiliary, emergency and jacking pumps are also supplied.

The single l.p. feed heater for each set, together with the drains cooler, raises the condensate temperature to 166 deg. Fah. at design load. Automatic control is provided to prevent the feed temperature falling below 145 deg. Fah. during part load running. Special feed heating equipment will provide a temperature of about 180 deg. Fah. for use during Wigner release. Each main set is provided with a surge and a high level reserve feed tank. In addition two low level reserve tanks serve all sets.

The main condensers are of the twin shell

surface type designed for a vacuum of 28in with a cooling water temperature of 550 deg. Fah.

The main alternators are hydrogen cooled and are designed for a normal output of 87MW at 0·85 power factor, with 15 lb per square inch gauge hydrogen pressure. At the maximum output of 93·5MW at 0·85 power factor the hydrogen pressure is raised to 25 lb per square inch gauge. Generation voltage is 13·8kV. The main and pilot exciters are gear driven from the main alternator shaft.

Variable Frequency Sets.—A separate variable frequency set is provided for blower power to each of the reactors, with a spare set which can be connected to either reactor to provide standby capacity. Each set is designed for 33MW maximum and 28MW economic rating. The controlled frequency is from 12½ c/s to 50 c/s. The turbines are of the two-cylinder impulse reaction type supplied with high-pressure steam only, exhausting directly to their condensers with no feed heating. The condensate is pumped through the feed heater associated with the main sets. The governor and control gear for these sets is of particularly high accuracy. It contains an electrical sensing circuit combined with a hydraulically operated servo system. The alternators are rated at 33MW at 0·9 power factor at 3000 r.p.m. and generate at 11kV. The oil pumps, alternator cooling fans and exciters are separately driven.

Electrical Equipment.—Generator transformers step up the voltage from 13·8kV to 275kV. The high voltage cables leading to the switch yard are carried in a cable tunnel around the western end of the turbine house. Two station transformers of 275/11kV provide the station auxiliary supplies. The 11kV provides power for the CO_2 blower motors during commissioning. All other motors on the station above 150 h.p. are supplied with current at 3·3kV furnished by further 11/3·3kV auxiliary transformers. The 11kV switchgear on the variable-frequency supply to the blower motors has a rupturing capacity of 750MVA and has been successfully tested at this rating over a range of frequencies from 50 c/s down to 10 c/s. The 3·3kV and 450V switchgear for other supplies is conventional. Emergency power from the station battery will handle all essential auxiliaries for twenty minutes. The diesel generator sets start automatically on interruption of normal power so that ordinarily they should be furnishing emergency power within one or two minutes or less.

Steam Dumping Plant.—The capacity of the steam dumping plant for Hinkley Point is only 20 per cent of the output of one reactor as compared with 100 per cent at Calder. Since Hinkley Point is not designed to operate as a plutonium producing plant the dump condensers are not needed except for such services as providing a sink for shut-down heat and on starting to cover the periods when the turbines are not running.

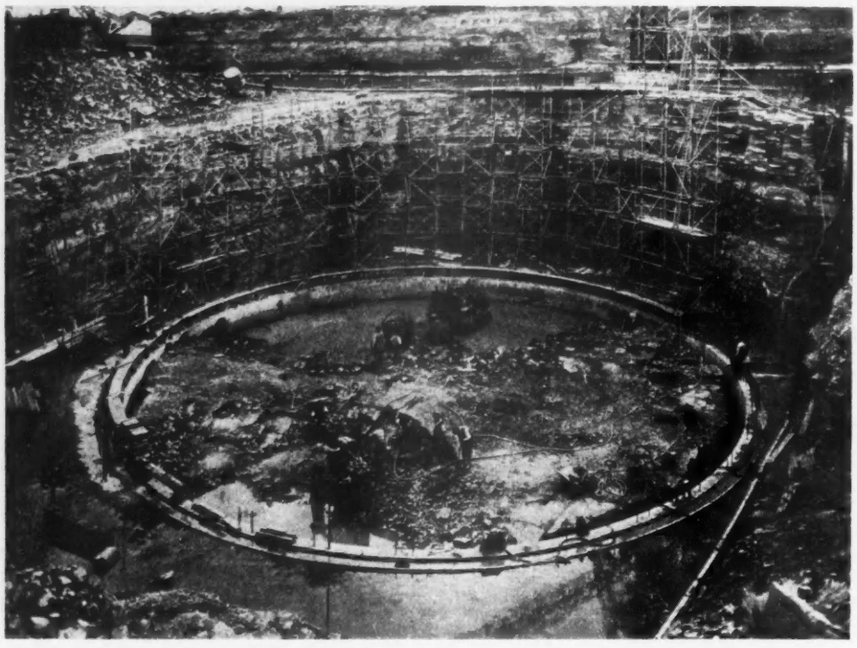
Steam Pipework.—Since the pressures and temperatures used are relatively low by comparison with those used in modern coal or oil-fired stations the choice of pipe materials and thickness follows well-established conventional practice. Because of the large volumes of steam, however, the pipe sizes and insulation required careful selection to maintain a balance between first cost and pressure and temperature loss. The steam mains from each group of six boilers associated with one reactor are combined into three 15in high-pressure mains and six 15in low-pressure mains. These mains feed into high- and low-pressure headers, one for each reactor. The headers are connected to each main turbine by one 15in high-pressure pipe and two 15in low-pressure pipes and to each other by single 15in high-pressure and low-pressure pipes. The steam connections for the variable frequency sets and for the dump condensers are taken from the cross over pipes.

Boiler Feed System.—The eight boiler feed pumps, each of 1,100,000 lb per hour capacity, are grouped around the centre of the turbine house. The pump drive is from 3·3kV squirrel-cage induction motors. The same pumps provide both h.p. and l.p. feed water, the l.p. water passing through throttle valves before reaching the boilers. The extreme simplicity of this system more than outweighs the small loss of power in the throttle valves. In addition to the main feed pumps the system contains two small emergency pumps, mentioned before, to provide water to dissipate shut-down heat. Make-up water is taken from the local town's water supply and treated in an ion exchange system. A chemical dosing plant is also provided.

Circulating Water System.—The intake for the circulating water system is in deep water about 700 yards out in the Bristol Channel. Two intake tunnels, each of about 11ft equivalent diameter, connect the intake to the pump house. Four culverts connect the pump house to the main and auxiliary set condensers and various coolers. The discharge is via four culverts to a seal pit to assist syphon recovery at low tide. From the seal pits culverts take the water to an open channel in the foreshore which finally discharges the water at a point about 800 yards east of the intake. One feature of the design is the very high tidal range. Extreme low water is −21·5ft O.D. and extreme high water +26ft O.D. giving an extreme range of 47·5ft. The total water quantity, 35,000,000 gallons per hour, is handled by six vertical-spindle, centrifugal pumps driven by 3·3kV squirrel-cage induction motors.

The intake structure will be built as a caisson in a dry dock on shore, towed to position and sunk on to a prepared bed. Access is by means of a 7ft tunnel from a shaft near the pump house. The pump house is designed with a forebay, a screen chamber carrying eight 60in travelling band screens, a pump suction dock and a pressure chamber to which the culverts are connected. Extensive model testing has been carried out on both the pump house and the intake structure. Further details of the cooling water system are given below.

The concrete structure of the "island" will be floated, Mulberry-Harbour fashion, from a dry dock on the west side of the site, illustrated here. This dry dock has been finished and its semi-circular ring of steel sheet piling will be removed, at the appropriate time and tide, for the intake structure to be towed into its permanent position in the spring of next year. The structure itself will be a reinforced concrete caisson, 60ft high and 96ft in diameter, in the shape of an upright cylinder and, with its false bottom, will have a dead weight of 3000 tons approximately when towed into position. When placed, it will rest on the sea bed on eight "spud leg" supports, hollow steel columns 60ft long and 4ft in diameter. A ring of steel piling previously suspended around the floating structure will then be driven into the sea bed to provide a cofferdam, within which the intake and tunnel connections will be completed.



In the 60ft deep dry dock area protected from the sea by a steel piling cofferdam, the cooling water intake caisson is being built before it is floated 2000ft out to sea and sunk into position. This illustration shows the circular concrete footing being constructed ready for the erection of the cooling water intake caisson

The intake system has been designed to supply a second Hinkley Point station, the probable cooling water requirements of which would be 50,000,000 gallons of water an hour (totalling 85,000,000 gallons for the two), but only the offshore ends of the two larger 13ft diameter tunnels will be constructed at the present stage.

On the shore side, an 18ft diameter, approximately 100ft deep, access shaft has already been sunk behind the completed sea wall (which thus acted as a cofferdam for these works as well as a general site protection) and a 7ft diameter pilot access tunnel is being driven seawards. This will be lined with cast iron segments. Where they leave the access shaft the two main water tunnels, concrete lined, will have an invert level 92ft

below the finished ground level of the site.

Driving will begin from a cross heading, itself driven from the access shaft, and proceed to the intake structure in one direction and back to the pump house in the other. Seawards it will stop short of the intake structure until the main portion of the work is completed there. Then tunnels from the intake structure will link up with them.

Each of the inlet tunnels will supply one-half of the pump house forebay, and from the pump chamber water will flow to the condensers in the turbine hall through twin delivery culverts, 8ft 6in square, constructed in open cut and approximately 35ft below finished station level.

The inlet culverts have been designed to carry the outlet culverts directly on top of them for a distance of 700ft from the turbine hall. The outlet water will be led 1100ft in all to a reinforced concrete seal pit behind the sea wall at the eastern edge of the site. From there, it will be discharged through a further 800ft of concrete culverts to a head wall offshore, beyond which a channel will be excavated in the open water. Final discharge will be some 2300ft east of the intake point. The offshore outlet culverts and the head will be built in one large steel sheet-piled cofferdam over 800ft long in which excavation for the culverts is now proceeding.

The cooling water pump house with its adjoining screening bays, suction dock and pressure chambers will all be below ground level with an adjoining chlorination house above ground level.

The excavation to the pump house will be carried out in open cut. A series of benches will be formed, the batters between each being progressively steepened with depth. The forebay is divided into halves and each of the water tunnels is to supply one-half.

Each half of the forebay will consist of a screen bay containing a line of coarse screens, four fine band screens, and a suction deck. The two halves of the forebay will be interconnected between the screen bays and between the suction docks and these interconnections can be closed by steel gates. The water is to be drawn from the two suction docks through bell mouthed pumps suction pipes by six 72in diameter constant-speed vertical-spindle centrifugal pumps.

Immediately on the delivery side of each pump will be an automatic isolating and non-return valve, actuated electrically by the pump motor, thereby closing immediately in the event of a power failure. For maintenance purposes, a 25-ton electric overhead crane traverses the length of the pump chamber.

At the back of the pump chamber there will be two interconnected pressure chambers each connecting three pump delivery pipes to twin delivery culverts leading to the turbine hall.

Sea Wall

The sea wall, 3500ft long, which protects the whole frontage of the site, has been completed on time. In order that the excavations located behind the sea wall and in front of the existing cliffs could be started at the beginning of the summer of 1958, the first 2000ft was programmed and constructed in a period of five months. The work was executed despite the winter and spring tides which have an extreme range of 40ft, of which 17ft is experienced at the position of the wall, some 300ft in front of the existing cliffs.

The wall, constructed between tides, was formed in three main lifts. The first 1ft comprised the toe and foundation of the wall which was put down a minimum of 2ft and a maximum of 7ft into the foreshore, depending upon the strata exposed in trial pits previously dug along the line of the wall. The foreshore consists of an irregular series of limestone layers approximately 9in thick bedded in shale and inclined at approximately 10 deg. to the horizontal. The second lift comprised the main tapering portion of the wall. Large prefabricated steel shutters were lifted into position by "22 RB" excavators rigged as cranes and travelling on rock-filled access bank behind the wall. The third section comprised the top lift and bullnosed parapet.

The wall was constructed in alternate 21ft and 4ft lengths, the latter being cast a minimum of twenty-eight days after the former. Immediately the shutters had been removed from the main lifts of the longer bays a back shutter of precast concrete slabs was applied to the construction gaps in order that the wall could be back-filled without delay.

The concrete mix used in the wall contained no additives but was a richer mix than used generally on the station and contained 560 lb of cement per cubic yard.

Progress on Power Station Site

The initial task on the construction site involved the removal of 200,000 cubic yards of soil and clay excavation to form the general station level at +36·00ft O.D. By use of fast-moving scraper equipment, this was practically completed by early January, enabling the excavation in rock for the reactor foundations to start that month. Some 32,000 cubic yards of rock excavation have been taken out for foundations of reactors Nos. 1 and 2, as well as deep excavations for the blower house.

By the beginning of this month on No. 1 reactor the main biological shield construction was about 85 per cent complete, and the secondary shield approximately 60 per cent complete. Concreting in reactor No. 2 foundation started late in June and some 4700 cubic yards have been placed to date. The reinforced concrete subway for conveying the high-voltage cables from the turbine house to the 275kV switchgear compound, south of the main station site, is approximately 80 per cent complete.

About 2200 cubic yards of concrete have been placed for the foundations of the 250ft gauge track to carry the 240ft high Goliath crane, capable of lifting 400 tons. Erection of the giant crane is due to begin shory.

An 18ft diameter access shaft for the intake tunnels has been sunk to a depth of approximately 100ft, and lined with cast iron segments, and work is now proceeding on driving an access tunnel and cross headings to the water tunnels, 3000 cubic yards of rock having been excavated.

Rock excavation for the turbine house and associated cooling water culverts, started in May, is now nearly completed, some 80,000 cubic yards having been removed, 2300 cubic yards of concrete placed in the turbine house and 1800 cubic yards in the culverts.

Temporary works have been prepared for Babcock and Wilcox to carry out site fabrication work on pressure vessels, steam-raising units and associated pipework. An area of 215ft by 200ft by 12in thick concrete has been laid to form the pressure vessel erection area and sections of the building are on site, whilst another area 227ft by 100ft has been laid for hydraulic and radiographic testing of the steam-raising units.

A large "Arcon" building, covering an area of 168ft by 138ft, has been erected for fabricating the steam-raising units, and another "Arcon" building 218ft by 67ft has been built for shot blasting all tubes and elements which go into the steam-raising units. These buildings can be seen in the background of the illustration on page 597.

In addition, works, including stores, workshops, garages, and a boiler-house, have been constructed, and in the fabrication shop welding tests are in operation. The English Electric stores and workshop building is now in its final stage and will be ready for occupation by the beginning of November. Principal items in the Taylor Woodrow works include two 2 cubic yard capacity concrete batching plants, fed by conveyor belts.

Concurrently with the civil engineering work on site the steam-raising unit shell sections are now in course of fabrication in Babcock and Wilcox works, many of the 3in plates for the reactor pressure vessels have been formed, and the first courses are in an advanced stage of fabrication for the ultimate site construction of the vessels. At the group's headquarters at Whetstone, a separate workshop for the machinery of the graphite has been erected ready for full operation in the New Year. At the same time, manufacture will also start on the steam turbines.

Also work is nearing completion on all the major components of the Goliath crane that will be used in the erection of the reactor groups, and their parts will be shipped by sea via Combwich harbour for assembly on site in due course. When erected, this crane will be the largest Goliath crane in the world, standing some 250ft overall and with a lift of 400 tons to a height approaching 200ft.

Combwich Wharf

What is virtually a new port has been created at the village of Combwich, 4 miles from the power station. Civil engineering work, now completed, enables ships of up to 1500 tons to eliminate road transport problems by unloading heavy equipment which the consortium has to bring to Hinkley Point.

Combwich, on a small tributary of the River Parrett and north-west of Bridgwater, had a lively small ship trade, latterly carrying bricks and tiles, which fell off in the '30s. The facilities have been revolutionised by works, including the provision of a 200ft wharfage, the installation of a 45-ton derrick and a 150-ton fixed crane, a hard standing for temporary storage, a reinforced concrete bridge to carry a new service road, ½ mile of which is new or improved, over Combwich Pill.

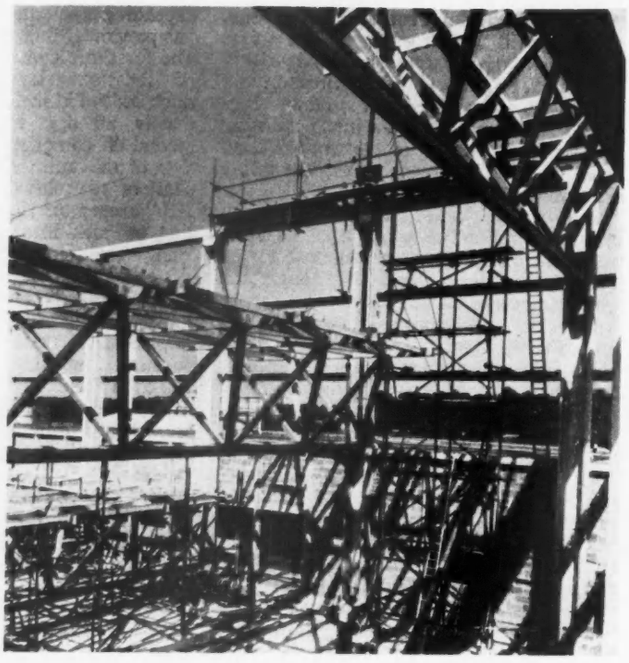
It is expected that once shipments start there will be one arrival a week allowing a total of 30,000 tons of cargo to be handled over the next two years. The frontage involved the excavation of 20,000 cubic yards of mud and silty clay and the subsequent driving of 340 tons of sheet piles (Larssen No. 3) in the form of a cellular cofferdam 26ft wide and 200ft long, running parallel to the shore with a turn shorewards at the western end to join up with the access road to the wharf. The cofferdam was filled with compacted quarry waste and topped off with a tarmacadam surface. Two large dolphins, each consisting of a group of box piles 42ft long, driven 15ft into the river bed, and capped with reinforced concrete blocks, have been constructed at the eastern end of the wharf to facilitate the berthing of ships.

Hinkley Point power station is being built for the Central Electricity Generating Board by the English Electric-Babcock and Wilcox-Taylor Woodrow Atomic Power Group, which has its headquarters at Whetstone.

Jubilee Conference of Structural Engineering

No. I

The fiftieth anniversary celebrations of the Institution of Structural Engineers have centred round a three-day conference, which was held at the Institution building in London last week. About thirty-five papers were presented at the conference, covering all aspects of the structural engineer's work, and generally aiming at emphasising future trends. In this review of the conference, one or two topics have been abstracted, in brief descriptive notes, from this comprehensive set of papers, and a rather longer abstract has been reproduced from Mr. F. J. Samuely's paper on skin stuctures.



DURING last week, on the mornings of Wednesday, Thursday and Friday, technical sessions were in progress at the Institution of Structural Engineers' building, at 11, Upper Belgrave Street, S.W.1, and simultaneously at the Institution of Naval Architects' building next door, when the various papers of the "Structural's" fiftieth anniversary conference were discussed. All aspects of structural engineering were included in the conference, each session covering a group of three or four papers and having a general reporter. The conference was, to some extent, international in character, there being several papers from authors overseas. The sessions could be roughly classified as: structures for power projects; bridges; "skin" and composite structures; research; analysis; structural methods in steel; precast concrete; foundations; airfields, docks and harbours; and special structural problems and materials. The emphasis was generally upon the future, and recent advances, in design and in the use of the various structural materials for example, were described in such a way that the trends of development now with us were brought out.

In the following notes we have not attempted to review the conference comprehensively but have selected one or two topics from amongst the mass of information presented in the thirty-odd papers, to give an idea of some of the more interesting matters which the conference brought to the fore. Under each of the cross-headings below we have abstracted from the conference papers, and the title of the paper and its author are given in brackets at the end of each abstract.

Skin Structures

It is remarkable that, while all other methods of building have undergone considerable development during the last 2000 years (even while brick and stone were the main materials used, and certainly when steel and reinforced concrete arrived), there is only one new construction in space during all that time—the Gothic vault—and no new thought at all in dome structures before the middle of the nineteenth century; in fact, very little had been done up to the first world war. It may be assumed that the reason for this backwardness is to be found in the desire to give preference to constructions whose full effect can easily be shown on the drawing board, i.e. where all centre lines and parts of a structural member, together with the loads, remain in one plane. Domes and similar structures do not really fit into this pattern, and even the Gothic vaults almost completely disappear with the first attempts at mechanisation associated with the Industrial Revolution.

Another reason for the lack of development of such structures is the fact that even to understand them, not to mention the calculation of stresses, considerably greater understanding of mathematics in space is necessary than for structures in a plane. The understanding of the necessity of stress calculations goes back to the beginnings of wrot iron construction. At that time such space mathematics were still a theoretical science which was certainly not taught in schools or other institutions for educating engineers. During the second half of the nineteenth century a few domes were constructed in latticed wrot iron and steelwork, one of the notable examples being the dome of the Reichstag in Berlin built in 1876. But these latticed domes were structures which the ordinary engineer hardly understood, if indeed he knew of their existence. It is since the beginning of this century, when at least a smattering of analytical geometry of space became accessible to the engineering student, that engineers started thinking more seriously about further possibilities, and when Dischinger in 1927 developed a theory of monolithic shells primarily adapted for reinforced concrete this achieved sufficient popularity to enable all structural engineers at least to know what was meant by either cylindrical or spherical shells. Even to-day the design and calculation of such shells is not yet a subject for graduate courses at the universities. The principle of the theory is the realisation that, in a curved slab when loaded, a system of tension and compression stresses can develop, parallel to its surface, so that, when properly supported, only insignificant bending (due to secondary stresses) develops, and this slab can do the work which otherwise requires heavy beams. However, such shells, and particularly the cylindrical ones, are carried out in many instances to-day, and the shapes that can be constructed with a pure shell are so restricted in application that it may be said that it has been relatively easy to progress with their science so completely that all that remains for the future is to disseminate the methods of calculating them throughout the structural engineering profession.

There have been other developments, probably more involved in conception, which have not found the same popularity as the shell. These promise a very much greater variety, and while they are still in their infancy will probably excite the minds of engineers and architects during the years to come. The three most promising pointers are the following:

(*a*) The folded slab construction—the replacement of a continuous curved surface by a series of flat or curved surfaces. In this way a cylinder may be replaced by a prism, a cone by a pyramid, and a sphere by a number of truncated pyramids each resting on top of the one before. Finally a great number of combinations of flat and curved surfaces is possible, which cannot be derived from a mathematical surface.

(*b*) Latticed construction arranged in the surface of roofs, instead of forming girders and trusses—this enables metal to play its part, but can also utilise precast or prestressed reinforced concrete and timber.

(*c*) Surfaces of a freer curvature than either the cylinder or the sphere. Foremost in this group to-day is the hyperbolic paraboloid.

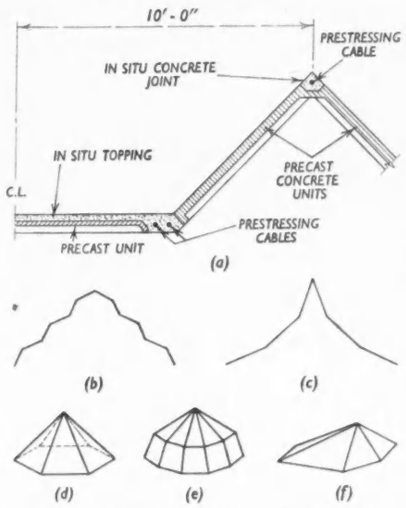
It stands to reason that there will be applications in which two of these developments, or all three, are in fact combined.

Folded Slab Construction.—If a cylinder or dome, in which the internal forces act for the most part tangentially to the curvature, is replaced by a series of straight facets, compression and tension develop equally parallel to the surface, but additional stresses are caused, producing local bending because the continuous lines of tension or thrust which develop in a curved surface cannot accommodate themselves completely in a series of planes which form an angle with each other and intersect in quoins. So from a purely theoretical point of view the cranked surface is inferior, but otherwise it has advantages.

It allows easier construction where it is not possible to use standard formwork, the question of glazing can often be simplified, precast concrete and latticed steel can more easily be used, and last but not least, calculations have been established which are much simpler than those for a continuously curved surface.

For practical reasons the most exploited shape so far has been that of the prismatic slab. In its simplest shape this could be a zig-zag line or, only slightly more complicated, the one shown in the sketch (*a*), which was used for an assembly hall for a comprehensive high school in South London.

While some shapes turn out better than



Structural forms possible with folded slab construction

others from the point of view of stresses, very complicated functional requirements can indeed be satisfied, and it is perfectly possible to introduce shapes like those shown in (*b*) and (*c*), which may be useful for cinemas and exhibition halls, as well as many others which no one has thought of up to the present.

The use of prismatic folded slabs is not restricted to roofs only. Wherever there are surfaces inclined to each other, it is possible to make use of their quoins, and particularly suitable applications—of which there are only a few at present—are stairs and galleries in theatres. It is, of course, quite possible to have non-prismatic folded slabs, and they will no doubt be used where they are specifically required. It is obvious, however, that there are so many advantages in the construction of a prismatic slab due to the consistency of cross section that wherever possible they will be given preference.

A development which is quite likely, and which will have an influence even on planning, is the possibility of roofing over polygonal plans in a way which is related to the plan. Hexagons, octagons, or any similar areas will be very suitable for certain purposes, such as exhibition halls, churches, hangars, &c., and in (*d*), (*e*) and (*f*) some of these possibilities are indicated.

Latticed Construction.—Remarkably enough, although latticed wrot iron and steel constructions in the shape of either a vault or a dome were already known during the nineteenth century, concrete solid constructions have overtaken them and even to-day, are much more popular. One of the reasons for this is that for a long time space connections of structural members—and that generally meant steelwork—did not appear very desirable. The general attitude has changed somewhat with the advent of tubular construction, which of course for its part could not happen until welding was sufficiently advanced. To-day, latticed steelwork with a light roof covering can very well hold its own economically compared with both reinforced concrete shells or with traditional steel construction.

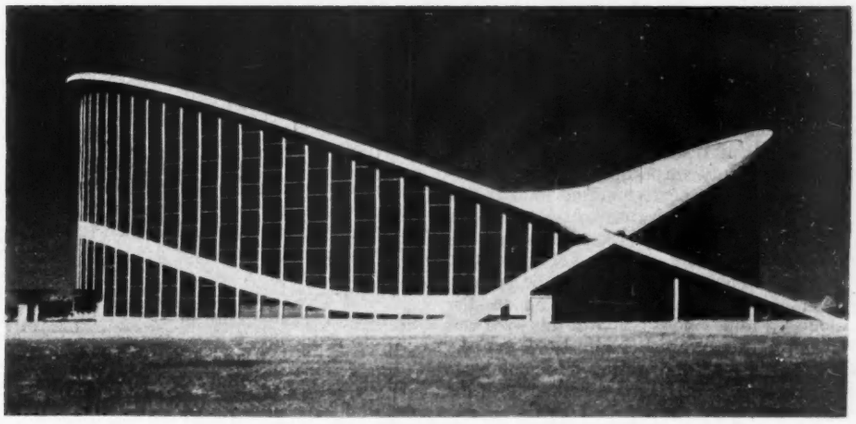
Latticed construction can in every respect replace all folded slabs, and the only real difference is the fact that each plane, instead of being solid, is represented by a girder built up from chords and filling members. Again, there is no need to consider only steelwork for latticed construction. Light metal, precast concrete and timber are all possibilities. The heading illustration shows the construction of a roof for a repair hangar at Gatwick airport where latticed construction was used, consisting of precast concrete lattice, the lower chord of short units being prestressed with post-tensioned tendons while the diagonals which are in compression are just precast, and those in tension are prestressed with post-tensioned tendons.*

Hyperbolic Paraboloids.—Some years ago hyperbolic paraboloids were introduced, the first large application being in Raleigh, North Carolina (reinforced concrete arches with steel cables) as illustrated. It is very interesting to note that there is nothing in the way of stresses that particularly demands this particular shape. It has been selected and developed for two reasons : (1) the hyperbolic paraboloid contains straight lines—it can in fact be explained as a straight line on the skew rotating about an axis. This makes the understanding easier, but actually the geodetic quality of incorporating straight lines in its shape is a mere accident, and these lines are in no way the lines of principal stresses. (2) The straight line simplifies manufacture. A timber shell of this shape can be constructed from a number of boards which are not parallel to each other. Similarly, a concrete construction could have some formwork made from straight timbers and yet producing the desired curved surfaces.

Finally, as in the case of Raleigh, the roof can be constructed from a number of wires suitably stressed, each of which forms a straight line but no two of which are parallel to each other. It is not meant to be a criticism of this shape if it is pointed out that it has been developed from entirely practical considerations which have nothing to do with its space action. However, we know from previous experience that this has always been the way of development—at first, practical shapes and those which can most easily be grasped have been devised, but our technical knowledge and understanding of mathematics are both progressing all the time, and one may predict that the hyperbolic paraboloid, after possibly becoming in the near future as popular as shells are to-day, will in its turn be replaced by something else. We can look forward to a future of this kind, but we cannot prophesy the shapes which will come, any more than the keenest engineer of the year 1900 could have predicted the hyperbolic paraboloid.

(From "Skin Structures" by F. J. Samuely.)

* See THE ENGINEER, page 973, June 27 last.



Hall at Raleigh, North Carolina

RESITING BUILDINGS

For many years, it has been possible to avoid demolitions by moving houses bodily to new sites. But such possibilities were very limited, as the tracks were extremely expensive to construct, having to be level as well as perfectly rigid to avoid cracks occurring during transit. In addition, changes of direction and rotations were extremely risky, as the effect on the buildings could not be accurately assessed in advance.

In 1950, however, a radical change took place. It was in the same year that the Paris branch of Christiani and Nielsen was given the task of moving a group of fourteen villas, which lay in the path of a projected main highway leading out of Paris. A design, based on entirely new principles, was evolved. The new method consisted of a system of hydraulic jacks inserted between the building and the carriages, and coupled in such a way that they acted (statically speaking) as three simple supports, thus making the system as a whole statically determinate.

The jacks in each of the three groups were proportioned and interconnected in such a way that the hydraulic pressure on each piston corresponded to the load at the point concerned, and thus, when one of the carriages (due to unevenness of the track) tended to tilt in either dimension, the difference in height was automatically balanced by a movement of the piston, while the effect remained constant.

This method allowed the use of normal elastic railway tracks without danger of any cracks occurring and, in addition, made it possible to turn the carriages, one by one, at the points of intersection.

Practical applications are steadily in the course of development, and in France, between 1951–1957, about seventy houses have already been resited according to the new principles. Most of these buidings were of brickwork, but steel structures and rein-

forced concrete buildings have also been moved.

The weight of the buildings varied from 100 to 2500 tons. The distances moved were up to ¼ mile and the routes included curves, changes of direction, rotations and gradients, both up and down.

The main components utilised in the moving of these houses were as follows :—

(1) A supporting system of beams which transmits the weight of the house to the hydraulic jacks mounted on the carriages.

(2) Devices (where required) for concentrating the load in order to reduce the number of carriages and so reduce the cost of earthworks and tracks.

(3) Carriages, and the hydraulic jacks mounted on them.

(4) Tracks.

(5) Propulsive devices.

The number of carriages required depends on the size and shape of the building, the distance it is to be moved, and the number of changes of direction. Brickwork will normally span 12ft to 15ft and, if the distance to be travelled is short and in a straight line, one carriage under each of the points, found on the above basis, will be the general rule.

The supporting beams are generally 8in to 12in deep steel joists with parallel flanges. Most frequently, these are laid along the main walls, one on each side, and the brickwork is carried by short cross beams between them. The beam system is laid on a plane immediately below the supporting ground floors, where such floors exist. The beams transmit the weight of the house to the hydraulic jacks mounted on the carriages.

For distances exceeding approximately 100ft and routes which include rotation of the building or changes in the direction of movement, it will usually be found most economical to concentrate the load over fewer points of support, thus reducing both the number of carriages and of tracks. There are two ways in which this load concentration may be realised : either by preflexing the beams between their supports or by prestressing the brickwork in a horizontal direction so that its safe span may be increased.

Preflexion is accomplished by inserting a secondary system of small jacks between the beam and the brickwork, the jacks being coupled together hydraulically. The models used have capacity loads of 15, 22½, 30, 37½ and 45 tons. They are spaced up to 12ft to 15ft apart, so that the brickwork may span freely between them, and with diameters of pistons corresponding to the load (found by calculation) that will act on each jack. When spacing and diameter have been correctly determined and the jacks mounted, pressure is applied to the hydraulic system. When the pressure corresponding to the calculated total load is reached, this load will be transmitted to the main jacks on the carriages through the beam. The small jacks are then locked and remain locked until the house has been resited.

For houses with walls up to 25ft to 30ft long, it may be more advisable to prestress the brickwork than to preflex the beams, assuming that the brickwork is strong and thick enough to allow this. Prestressing is accomplished by means of two rolled steel sections acting as ties, one along each side of the wall. At each end they are coupled by means of a short cross beam. A hydraulic jack is inserted between this and the wall, and when pressure is applied to the jack, the tie is loaded and the wall prestressed.

The first houses were moved by means of steel cables and blocks operated by hand winches or electric winches. Only a very low speed was possible with the hand winches, but with the electric winches a speed of up to 3 to 5 yards per minute was attained. This form of propulsion, however, has now been abandoned, because, on account of the elasticity of the cable, the motion becomes jerky and the building is continually subjected to shock.

Hydraulic jacks which push the building forward are now used instead of winches and cables. The base of such a jack bears on a cross beam which lies across the two rails to which it is held by means of steel wedges. The end of the piston-rod presses against the cross beam of the carriage. Where the carriages are higher, however, especially when mounted on wheels, an intermediate cross beam is laid across the rails, so that the jack may remain horizotnal, and the power is then transferred to the carriage through an inclined compression bar.

These jacks may exert a force of from 20 to 50 tons. The length of stroke of the piston is normally up to 1 yard, at a speed of about 8in a minute, The mean speed of the building is normally about half of this, i.e. 4 to 5 yards per hour, allowing for time lost in retracting the piston, &c. The piston is double-acting. It can therefore be retracted as well as expelled by hydraulic pressure. When the piston, and with it the building, has moved one stroke, the fluid is fed into the other side of the piston, the wedges are struck loose and the cross beam at the end of the jack is dragged one stroke forward by hydraulic power, ready for the next working stroke.

When the direction of movement of the building is to be changed, each of the carriages must first be turned and placed on a track corresponding to the new direction. In order to accomplish this, a bearing plate is built into each of the points of intersection of the various tracks. A hydraulic jack is placed on it and presses upwards against the centre of the steel chassis of the carriage. This causes the piston in the main jack on the carriage to depress (and the pistons in the other jacks of the same system to rise), the carriage rises and the wheels are lifted clear of the rails. The carriage is then turned and lowered on to the new track. No secondary static reactions are set up by this operation, as the building rests on a statically determinate three-point support system and any of the carriages may be raised or lowered (within limits determined by the length of stroke of the supporting pistons) without disturbing this system.

(From " Resiting of Structures," by Kurt A. Olsen.)

(*To be continued*)

Electric Cables

I.E.E. PRESIDENTIAL ADDRESS

By S. E. GOODALL, M.Sc.(Eng.), F.Q.M.C.

The inaugural address given on October 9 by Mr. S. E. Goodall as president of the Institution of Electrical Engineers can be considered in two parts. The first contained a short history of some of the contributions that have been made to the art of cable making. The second dealt with post-war developments in electric cables, and abstracts from this part of the address are given below.

THE second world war had far greater effect on the work of the cable engineers than the first had done. Up to the beginning of the war, certain basic materials and processes had become so well established that it had begun to look as though they would never be seriously challenged. Since the end of the war, however, the position has changed very drastically, and I propose to draw your attention to some of the more important of these changes, which have had a profound effect upon the general economy of cable making.

The primary factors which have brought about these changes are :

(i) Introduction of new plastics.

(ii) Need for greater economy in the use of materials.

(iii) Introduction of synthetic rubbers.

(iv) Advent of entirely new processes due to rapid growth in the cable plant manufacturing industry.

(v) Development of automatic control systems.

(vi) Competition in world markets from Continental manufacturers.

(vii) Increasing demand for cables for special purposes and arduous conditions, such as high temperature, low temperature, operation after fire, &c.

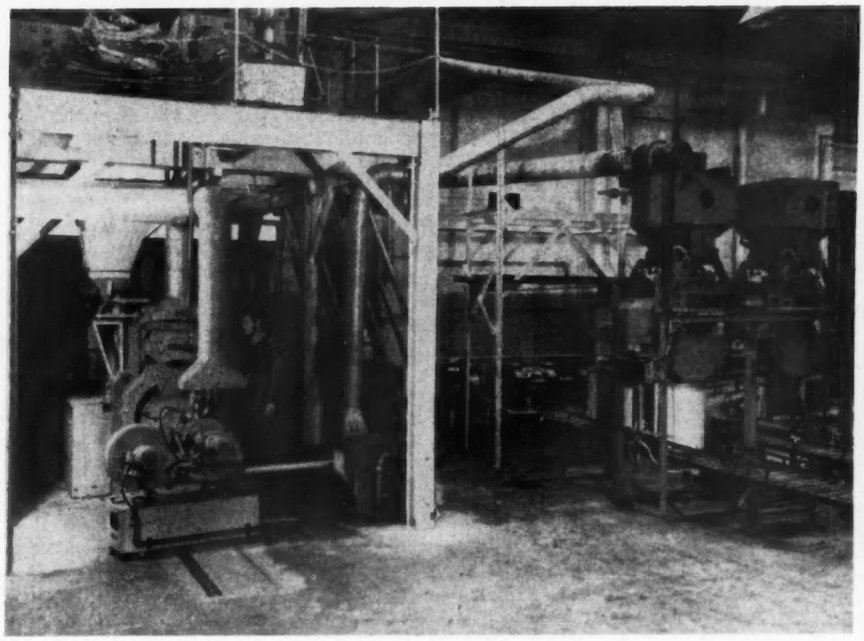
P.V.C. Insulation

Of the several plastics materials produced in the last twenty or so years, polyvinyl chloride has so far proved to be the most important for general cable-making purposes. Direct extrusion methods are employed for both core and sheath of a wide variety of cables, many of which were formerly produced solely by using rubber. At first, attempts were made to extrude p.v.c. by using plant designed for the extrusion of rubber compounds, and although some progress was made, it was soon realised that specially designed plant would be required for efficient production. Considerable progress had been made by one or two plant manufacturers in the United States ; consequently, during the war, plant was imported from America for this purpose and allocated to several British cable makers. Since that time, however, improved plant has been evolved in this country, and in some respects, at least, it offers advantages by comparison with American practice.

The preparation of p.v.c. compounds for the different purposes required by users is a highly complex and specialised study in itself. Some p.v.c. compounds are now obtainable from the chemical industry in a form suitable for the extrusion process. Those cable makers who use large quantities and/or supply special-purpose cables, find it desirable, or necessary, to purchase the polymer, plasticisers, stabilisers and other ingredients, and evolve their own compound formulæ. In addition to the elaborate mixing plant required, further equipment is necessary in order to produce the compounded p.v.c. in suitable pellet, or granule, form for feeding

into the hoppers of the extrusion machine. Mixing plant as used for rubber compounds has also been employed successfully for p.v.c. compounds. The accompanying illustration, however, shows one of the most modern plants recently installed specifically for the preparation of p.v.c. compounds. Not only does this installation produce the compounded p.v.c. in suitable form by a continuous process, but specially designed arrangements are incorporated so that the proportions of various components can be altered by presetting, and thereafter these proportions are maintained automatically.

While on this subject, it may be as well to mention another growing use of p.v.c. which has recently required further capital investment, namely, anti-corrosion servings. In order to protect the lead or aluminium sheath of a cable, either from the corrosive effects of soil waters or from the acids produced when textile servings rot through bacteria attack, it is necessary to provide protective layers over the sheath and/or, where the cable is particularly important or conditions are very bad, protection over the armoured tapes or wires. It is often sufficient to provide lead-sheathed cables with bitumen compound held in position by layers of paper and cotton tape, or p.v.c. tape, but for aluminium sheaths and for the better protection of lead sheaths, a more impervious layer is to be preferred. Rubber has been used extensively for this purpose but, more recently, extruded p.v.c. sheaths have been successfully employed. This has necessitated the development of large p.v.c. extrusion machines which are installed in the paper cable factory.



P.V.C. compound-making plant

Polythene

The other plastic material which is of major significance in the industry is polythene. I have already mentioned the introduction of this material for high-frequency purposes. It is very suitable as a dielectric for low-voltage use owing to its excellent electrical properties. For such purposes as house wiring, fairly large quantities of cable have been used in this country, the polythene core being protected by p.v.c. sheath. Fortunately for the cable makers, relatively minor modifications to p.v.c. extrusion plant are required for the production of small polythene core. The fact remains, however, that they are now producing at least three varieties of these cables employing different materials for the same conditions of service. There are one or two important differences in the behaviour of the three materials which should be borne in mind when the problem of choice arises. Of these, I would mention the following.

Ordinary grades of polythene melt at temperatures slightly over 105 deg. Cent., so that cables using this material are more prone to damage by sustained overload or short circuit. It is true that some of the high-density grades now becoming available have slightly higher softening temperatures. Moreover, considerable improvement can be obtained by irradiating with neutrons in an atomic pile, or with electrons from a linear accelerator or high-energy Van de Graaff generator. Such treatment effects cross linkages between the molecular chains and so eliminates the sharp melting point. Instead, the material becomes rubber-like at temperatures of the order of 150 deg. Cent. Unfortunately, the process is expensive, and it appears unlikely that polythene treated in this way will be used for anything more than special applications. Polyvinyl chloride, on the other hand, becomes softer as the temperature increases, and while it has no sharp melting point, is subject to the disadvantage that serious deformation under mechanical stress could occur at the higher temperatures. Neither material is able to withstand the overload conditions that can be tolerated by vulcanised rubber, without serious consequences.

Polythene has also been employed successfully for higher voltages up to 11kV, although its use has been very restricted in this country up to the present.

Synthetic Rubber Materials

In addition to plastic materials, a number of synthetic rubber materials are now available. The monomers which form the base of these materials are usually obtained from the petroleum base by the cracking process, in which the complex hydrocarbons are broken down into simpler ones by being passed over catalysts at appropriate temperatures. Developments in this field have been more rapid in America than here, and although there was considerable need for synthetics during the war, interest has waned since, except for special applications and for export purposes. The styrene-butadiene type, usually referred to as GR/S, has no particular advantages over the natural product and is now very little used in this country.

Polychloroprene, or Neoprene, which contains about 35 per cent of chemically combined chlorine, is used for applications where good resistance to oil and water is required. It also has the advantage that flame does not spread along the material. It is, however, inferior electrically and is therefore usually employed for sheathings and not for dielectric purposes. Fortunately, plant and process problems are relatively minor.

Butyl rubber, which is a copolymer of iso-butylene and isoprene, is receiving increasing attention, particularly as it is specified for certain high-voltage export purposes. This material is resistant to oxidation and is of low chemical reactivity. Processing is, however, by no means simple.

Another particularly important synthetic is silicone rubber. This may be regarded as half organic and half inorganic, as the backbone of the molecular chain is a silicone-oxygen linkage, similar to quartz. It offers certain unique advantages, and for this reason is now being used in H.M. ships and in aircraft. It has exceptional resistance to heat, and will operate indefinitely at 150 deg. Cent., and at considerably higher temperatures for short periods. After a fire, cables will continue to function if not disturbed, as the residue is largely pure silica. Flexibility is retained down to −70 deg. Cent. The electrical properties are similar to those of natural rubber. Again special processing is required. Fairly large quantities of cables employing silicone rubber are now being produced.

Standards and the European Economic Community

In one respect the cable-making industry, and, indeed, the whole electrical industry, of this country has been fortunate. We have been assured so far of an ever-increasing home market on which to base a flourishing export business. Modern political trends, however, suggest that we may soon be facing Continental competition in our home market. It is true, of course, that should this happen Continental markets will also be open to us. Whether the redistribution of trade would be of benefit to British cable makers depends on many factors outside the scope of this address, but one important consideration, namely, that of standards, is worth examination.

Our own British Standards for cables have been built up over the years on the basis of experience of successful service under our particular conditions of installation and use. They are established and modified by B.S.I. Committees, on which representation by users is predominant. Much of the experimental work upon which they are based is conducted by the principal members of the Cable Makers' Association, who have established a structure of technical committees to provide this and other services for cable users. In addition, valuable basic information and data are provided by the staff of the Electrical Research Association, who have always been closely associated with cable problems, particularly those which have to do with rating. Our standards have formed the basis upon which many of the

Commonwealth countries have developed and are developing standards to meet their own requirements. Periodic Commonwealth conferences are held at which mutual problems are discussed, and whenever possible common policy is adopted.

On the Continent, there are one or two sets of standards which are different from our own in many respects. At the present time a great deal of attention is being devoted to the possibility of reconciling these differences in whole or in part. There are, of course, differing opinions in our industry and among the users concerning the desirability of adopting Continental standards in this country. For, let us face it, that is really what reconciliation of differences will very largely amount to, since we speak as only one voice in many of the international conferences, such as I.E.C. and C.E.E., where such matters are discussed. My own view is that the British cable user would be most unwise to agree to such drastic changes without very careful consideration of all the detailed factors involved. The whole subject of standards and standardisation is very complex.

Over standardisation and premature standardisation should always be avoided, as they retard technical progress and discourage research and development. On the other hand, our own British Standards provide the best possible safeguard and assurance of high quality, good performance and long life.

The Future Outlook

And now what of the outlook for cable making in Great Britain ? First, let us look at some of the technical possibilities and objectives.

Commencing with power cables for distribution purposes, the demand for the comparatively new non-draining paper cable has built up rapidly. This is the type in which the impregnant is a waxy material which is solid at operating temperatures. To-day, an appreciable proportion of all low-voltage and high-voltage cables up to 11kV are of the non-draining type, and there seems to be every indication that the demand will increase.

Meanwhile, considerable interest is being shown in the possibilities of plastic mains cables. P.V.C. has, of course, been used for some years for low and medium voltages for industrial installations. The Area Boards and the C.M.A. have been engaged recently in a joint study of the potentialities of p.v.c. mains cables, and a draft specification for further discussion has been submitted to the B.S.I. This covers p.v.c.-insulated wire-armoured cables for use up to 1100V, and provides alternative beddings under, and servings over, the armour. One alternative in each case is extruded p.v.c. It would appear that some small economic advantage may be achieved by using these cables, but, of course, a cheaper form of construction could be employed if it were possible to dispense with the armouring and use a concentric neutral. The problem of live jointing for service conditions is by no means a simple one, however. A system employing these cables would involve the use of protective multiple earthing, and this would present considerable difficulties to the distribution engineer. It must be remembered that any plastic is likely to be inferior by comparison with paper under severe overload or short-circuit conditions. It is evident that it may be some time before these cables are used very extensively in this country, although I am confident that we shall see some installations of appreciable magnitude in the near future.

At higher voltages, up to 11kV, polythene has been used successfully as a dielectric material despite the difficulty of ensuring an entirely void-free extrusion. For this reason, great care is essential during processing, and highly sensitive ionisation-detection methods are used as a routine check of the homogeneity of the extruded material.

There has been discussion recently in national and international circles concerning the potential use of polythene for super-tension voltages. At present it appears unlikely that any extruded plastic material will be used for such purposes except for submarine cables, where polythene may well offer some advantages, particularly for direct-current transmission. It is noteworthy that views were expressed at the C.I.G.R.E. meeting this year that the limits for polythene were likely to be 33kV a.c. and $\pm$200kV d.c. For modern conditions of greater power and higher voltages, it is now evident that the highly developed oil-filled cable system can meet all the requirements which are likely to arise for many years to come. Within limits, this is also true of some designs of gas-filled cable.

A good deal of money, time and energy has been devoted in recent years in attempts to produce super-tension cables capable of operating at high maximum working stresses. It is obviously undesirable to go too far in this direction as the attendant operating risks are of necessity increased. Moreover, the apparent economy in price afforded by removing two or three layers of paper from the dielectric may be more than offset by other operating economics when the true value of increased running costs is taken into account. I believe the C.E.G.B. engineers are now, quite properly, taking these factors into account.

The drive for economy in use of materials in the manufacture of cables is now running parallel with the drive for economy in the use of the cables themselves. Although it would be relatively easy to determine the maximum current which should be carried by a cable under given conditions of installation, it is by no means so simple to state appropriate limits in practice, as most cables are subject to varying loads often in a daily cycle. They may also be subject to overload for long or short periods, particularly in times of emergency, and may have to carry occasionally short-circuit currents of considerable magnitude for periods dependent upon the rate of operation of the protective apparatus.

Until comparatively recently, most supply engineers have adopted a fairly conservative policy with regard to choice of cable size for a given duty, and there is little doubt that a proportion of the cable buried in the ground in this country has never reached the maximum operating temperature for which it was designed. On the other hand, it is well known, although seldom if ever officially admitted, that some distribution cables, particularly at the extremities of rapidly growing load areas, have been subjected to considerable overloads. In view of the necessity for national economy in such matters, however, some important investigations on cable utilisation are now being conducted by the Electrical Research Association in conjunction with the Central Electricity Generating Board, the Area Boards and the cable makers. The primary objectives are to determine the effects of practical operating conditions with a view to better utilisation of cables already installed, and to provide a more satisfactory basis for efficient specification of cables for new systems. At the same time, work is in hand to determine the limitations imposed by short-circuit considerations.

Future developments in cables for wiring purposes are unlikely to be revolutionary. The trend towards greater use of plastic materials will undoubtedly continue. There will probably be continued effort in the direction of reducing dimensions, made possible largely by improved processing control methods.

As I have already indicated, a good deal of attention is being devoted to the development of cables capable of withstanding extremely arduous conditions. Much of this work has been concerned with cables for modern aircraft, where such considerations as lightness, toughness, ability to withstand extremes of temperature, or even to operate after fire, and to resist attack from modern fuels and lubricants are of importance. Some of the latest types of cables for such purposes are proving to be very successful in service, and there is little doubt that even the most difficult conditions imposed by aircraft designers will be met effectively.

Expansion of the use of silicone rubber for applications where higher-temperature operation is desirable, and/or where temporary operation after fire is required, will no doubt occur. For most purposes, it will be necessary to protect the insulation as the material is not resistant to all fuels and lubricants.

Improvements in p.v.c. compounds will extend the range of usefulness of this material, particularly for operation at slightly higher temperatures without material reduction in useful life.

All this, and much more, will undoubtedly be achieved by cable engineers, and we may be sure that we in this country will continue to play a leading part in many of the future developments.

There remains, however, for the cable-making industry as a whole, one fundamental problem which certainly must be tackled if we are to be able to face competition from abroad, both in home and export markets. It will be evident from the very limited range of examples that it has been possible to encompass in this address that the two bugbears of cable making are alternatives and variety. By this I mean alternative designs and materials for the same duties, and variety of size, type, colour, finish, &c., in the vast range of products. The former has particularly afflicted us since the last war and has led to constant demand for new plant and plant modifications far outstripping the gradual growth in gross demand for cables. The result has been that the industry as a whole now possesses surplus plant for many operations, although few, if any, of these operations are wholly obsolete.

Two Conditions for Progress

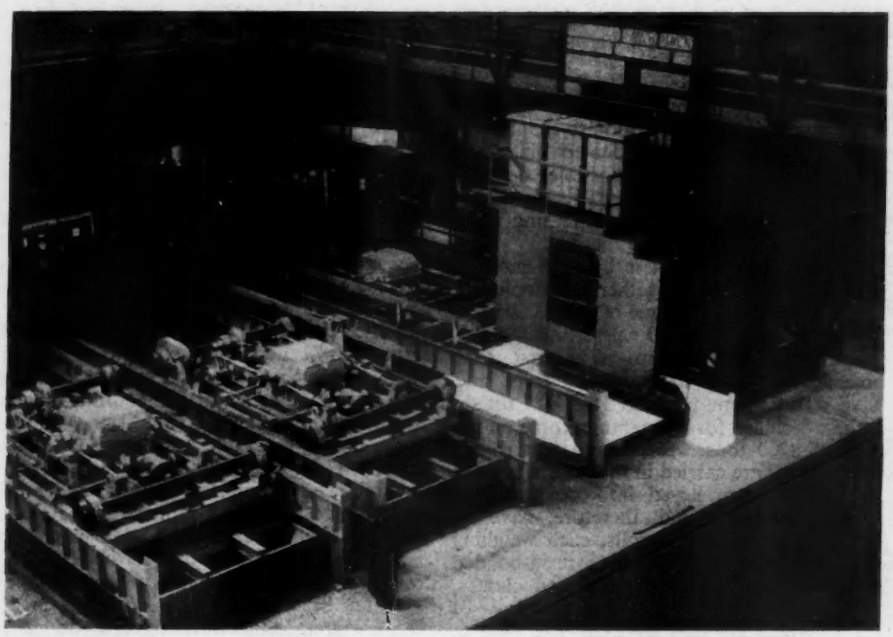
If effective progress is to be maintained, two steps would appear to be necessary. First, the industry must be prepared to face the consequences of rationalisation of production. This means effective regrouping of manufacture, and obviously requires close collaboration in one form or another between the different companies concerned. Technical collaboration has improved considerably in recent years, but this alone is not enough, important as it is to improve still further in this respect. Second, the cable users in their own and in the national interest must be prepared to accept some measure of restriction of choice. To this end, standardisation must be directed towards the elimination of unnecessary complication and not aim at the inclusion of every twist, turn and vagary that can be thought up.

Universal Beam Mill at Lackenby

No. I

The completion of the universal beam and heavy structural mill at the Lackenby works, near Middlesbrough, is the culmination of an extensive programme of development and modernisation which has been carried out by Dorman Long and Co., Ltd. This programme has involved an expenditure of over £60,000,000, of which the beam mill has required more than £18,000,000.

THE Lackenby universal beam mill which has been built by Dorman Long and Co., Ltd., is now in operation. It has been designed specifically for rolling what is, for this country, a new range of efficient beam and column sections ; universal beams from 36in deep with flanges 6½in wide, weighing 260 lb a foot, down to beams 6in deep and 6in wide, weighing 20 lb a foot are being produced. The mill has also been laid out to produce any of the present range of British Standard sections, but as it is expected that the more efficient universal beams will eventually supersede the standard joist in the larger sizes, it seems likely that, in addition to the new beams, the mill will only be called upon to roll angles, channels and piling sections.



The soaking pits ; a hot ingot is being lifted out by the 20-ton charging machine

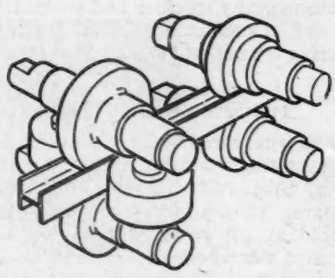
The whole of the mill installation is in one building which is adjacent to the Lackenby open hearth steel plant. This building has an overall length of 2914ft and a maximum width at its north end (where it is six bays wide) of 570ft. In general, the design of the building follows traditional lines, with diagonally traced stanchions and riveted or welded plate girders for the cranes. The standard spacing of the stanchions was fixed at 48ft after calculation had shown that a spacing of that order would give the greatest economy in the use of steel. But the layout of the plant required a number of variations in the spacing and as far as possible these were made in multiples of 16ft. The length of the building is divided into six approximately equal expansion lengths, each having a braced frame, nearly central, in each row of stanchions ; the braced frames are all portals joining two adjacent stanchions. One important item of the building is the walkway, 15ft above ground, which runs the full length of the mill bay. This walkway provides access, by stairs at frequent intervals, to every part of the mill floor.

The technique of rolling universal beams was effectively described by Mr. S. Barlow and Mr. G. Foster (of Dorman Long and Co., Ltd.) in a paper presented a year ago to the Institution of Structural Engineers.* The method is still fundamentally the same as in the first successful mill developed by Henry Grey and built in Luxembourg in 1902. In this kind of mill four rolls, two vertical and two horizontal, all with their axes in the same vertical plane, apply pressure to all faces of the beam at the same time, suitable adjustments to the four rolls being made between successive passes to keep the elongations of flanges and web equal. This roll arrangement is shown in the accompanying diagram. A separate stand, placed as close as possible to the main stand, and with two rolls only, works the edges of the flanges, squaring them and controlling their length. It is claimed that the four roll technique results in a better product as the substantially uniform elongation is applied to all parts of the section at the same time ; it also permits wider flanges than in the case of the present British Standard beam where two rolls work the steel of the flanges against the side walls of deep grooves. Further, whilst the two roll method requires a generous flange taper, the universal beam can be rolled with practically no flange taper.

The arrangement of the new mill at Lackenby, which has been designed for a weekly output of 8000 to 10,000 tons of beams, is shown on our inset plate. The photographs reproduced in this inset illustrate various important parts of the mill installation. At the south end of the building there are two cross bays, one for stripping the moulds from the ingots and the other containing the ingot soaking pits. The main mill bay is 2440ft long, has a crane span of 88ft 6in and contains all the mill stands with their attendant roller tables. Beginning at the south end of this bay, there are, first of all, the blooming mill and the bloom shear ; north of them are the bloom reheating furnace and the breakdown mill, followed by the four-stand billet mill. On the east side of the bay is the long roller table leading from the bloom shear directly to the two adjacent stands of the universal roughing mills ; further roller tables lead to the universal finishing mill and on to two hot saws. Next come the primary cooling banks, extending into the adjacent parallel bay, and the final cooling banks which serve the four straightening presses and the two roller straightening machines. East of the main mill bay are two houses containing all the main electrical machinery. The roll turning shop and the roll stocking space are situated beyond the north electric house. On the east side of the main mill bay is the main loading bay, with a 100ft crane span, which has a covered length of 1100ft and an open gantry 1050ft long.

Ingot Stripping and Heating

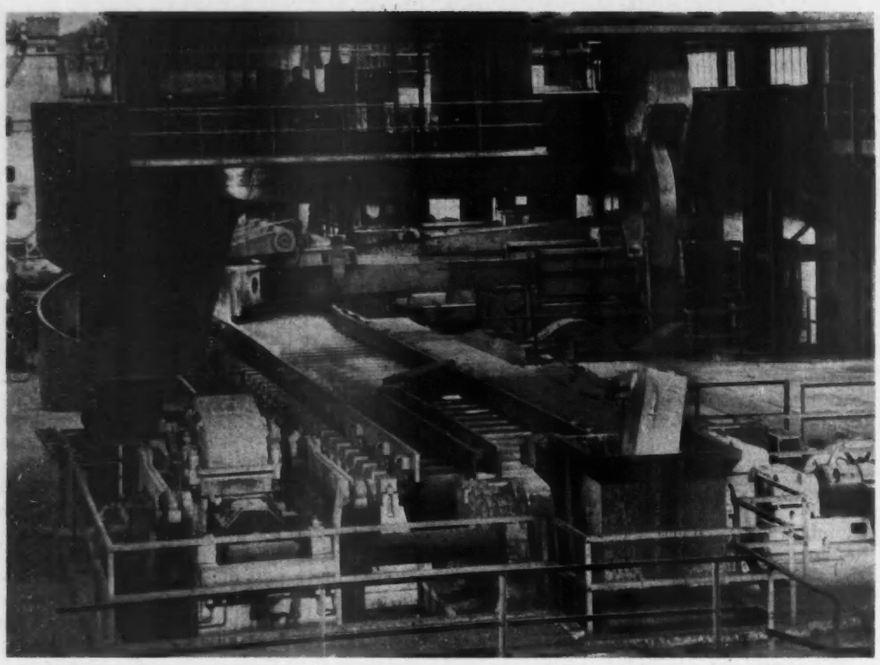
From the steel furnaces, the ingots in their moulds are shunted into the stripper bay which is 400ft long and has three rail tracks for the ingot casting cars. For the wide range of ingots required by the beam mill, from 4 tons to 20 tons in weight, a large number of moulds are needed, and in this bay are kept 4800 tons of moulds in five sizes. For stripping the heaviest ingots a stripping crane of 40 tons lifting and 400 tons stripping capacity has been provided, and for the smaller ingots there is a second stripping crane to lift 20 tons, with a stripping force of 120 tons. Adjacent to the stripper bay, is the bay housing the ingot soaking pits, and working between these two bays there are two rope-hauled transfer cars to carry the hot ingots from one bay to the other immediately after stripping. After stripping of the moulds, the ingots are lifted by the same cranes and loaded into one of two ingot transfer cars, by which they are carried through into the soaking pit bay.



Roll arrangement in universal mill

There are twelve soaking pits built in pairs and arranged in two batteries of six, with the ingot transfer between them. These pits are one-way fired by blast-furnace gas which can be boosted by coke oven gas. The single gas burner is in the rear wall, and the outlet port is below it, so that the flame passes over the ingots and back in a horse-shoe form. Each pit is 26ft long, 10ft wide at centre and

* The Engineer, November 8, 1957, page 673.



Approach table to the blooming mill. A hot ingot has been placed on the receiving chair, ready to send to the mill

13ft deep, and has a coke breeze bottom 2ft thick. Each pit is equipped with Escher recuperators, of steel plate construction, for gas and air ; the air recuperator lies horizontally and is followed by the vertical gas recuperator, 75ft long, which projects through the building roof and acts as a chimney. The recuperators give a combined preheat to the gas and air of 1000 deg. to 1200 deg. Cent. The pit lids are of American design and have an arched lining of 12in semi-silica bricks and 3in of insulation in a heavy steel frame constructed of plates 2½in thick. Each lid carries its own lifting and retracting gears under push-button control from the soaking pit crane cab. The lid of a selected pit can be opened any desired amount on the approach of the crane, and after removal of an ingot an impulse from the crane causes the lid automatically to close and lower into its sand seal. Combustion air and gas are shut off during the period that the lid is open.

The 52in Blooming Mill

Ingots from the soaking pits are placed on an ingot tilting chair leading to the blooming mill, by either of two 20-ton ingot charging machines. The crane driver not only operates the soaking pit cover, but is also in full control of the whole operation of taking an ingot from the pit and sending it to the mill. By control from his cab, he can remove the pit cover, lift out the ingot, and place it on the tilting chair. He then initiates a sequence which tilts the chair into the horizontal position, starts up the ingot receiving table which takes the ingot from the chair to the automatic weighing machine, and registers the weight of the ingot. Only then does the mill operator take control of the ingot and run it to the mill. The blooming mill has rolls of a maximum diameter of 52in, and a barrel length of 112in. Its primary purpose is to produce from the ingot the shaped blooms which are required for all the universal beams, each one of which has its own bloom, designed to give the correct relation between the volume of metal in the flanges and the web. As the plant is laid out to roll British Standard sections and billets, the blooming mill will produce rectangular blooms in addition to the universal beam. Further, in order to make the whole plant as flexible as possible, the mill has been designed with a high lift, to enable it to roll slabs for the Dorman Long plate mills if required.

The drive to the mill is by twin motors, each of 4000 h.p., together developing a maximum operating torque of 2,650,000 lb-ft, with a base speed of 40 r.p.m. and a maximum speed of 90 r.p.m. The cast steel housings each weigh about 100 tons, and have a minimum post area of 700 square inches, designed for a separating force on the rolls of 2700 tons. Breast and first rollers on each side are carried in the housings ; the housing feet are keyed into massive box-section bed-plates and, therefore, have no bottom ties. The mill rolls, each weighing about 30 tons, are carried in resin-bonded fabric bearings, in totally enclosed chocks, with lubrication by a continuous flow of water and grease from an automatic system. The endwise location of the roll in the chock is by means of a collar on the outer end of the free side roll neck, which fits between two fabric pads in the chock. At the barrel end of the chock, seals are fitted to prevent the ingress of mill scale to the bearings. Endwise adjustment of the rolls, for matching, is done entirely on the offside top chock, This fits into, and is supported by, a rider chock which is guided in the housing window, but has no adjustment. The top chock can, however, be moved relatively to the rider by means of three built-in hydraulic jacks, two of which push the chock inwards, taking with it the top roll, and one pulling the chock outwards. The three jacks are moved by a small hand pump.

The main housing screws, 18in diameter, are driven by two 150/300 h.p. motors, with Ward-Leonard control to give a screwing speed of 150/300in per minute. Indication is by Selsyn, with the dial in the operating pulpit. On the top platform there is a hydraulically operated screw relieving gear to free the rolls if they have been accidentally run together. Balancing of the top roll and the spindles is hydraulic, from a common accumulator air loaded to a top pressure of 1250 lb per square inch and with 150 gallons available capacity ; there are two roll balance rams, one on each housing, supporting the top chocks. Two beams, on which the top chock hangers rest, are hung on long links outside the housing, the upper ends of the links being pinned to crossheads on the rams. The mill driving spindles are 23in diameter and 32ft 9in long, with universal palm ends, supported by two bearings on cradles which are hydraulically balanced at the mill end. The problem of lubrication of the universal joints has been met by completely enclosing the joints at the motor end ; at the mill end, a grease feed from a mechanical pump in the oil cellar has been led through one of the spindle support bearings, and along the spindle direct to the slipper faces. The support bearing has been made capable of transmitting the pressure of the grease by fitting seals at both ends.

The double side guard manipulators have welded steel plate guards 25ft long and 4ft high. The whole of the manipulator traversing and tilting gear is on the side of the roller table adjacent to the motor house, leaving the floor at the offside of the mill completely free of obstructions except for the roll changing rig. All motions are electrically driven, and the whole of the gearing, including the rack teeth of the traversing rams, is totally enclosed and continuously lubricated with oil. The rams are supported on slippers which have been placed outside the width of the rollers, to bring them away from the path of falling scale. The bloom tilting gear, on the ingoing side only of the mill, is of a design developed in the U.S.A. to prevent damage to the machinery when the tilting fingers are brought down on top of a bloom. The tilting motor, mounted on the floor, lifts a narrow table by means of suitable cranks and levers. On this table runs a roller, mounted on the end of a lever on the manipulator guard, and connected by links to the shaft and arms on which the four tilting fingers are hung so that the tilting fingers lift when the table lifts, but if they fail to come down, the table falls away from the roller. The main tables at the two sides of the mill each comprise fourteen rollers of solid forged steel, 20in diameter and 10ft 6in long on the barrel, spaced at 29in centres and running on roller bearings. The four rollers nearest the mill at each side, which take the heavy punishment from the ingots while they are still short, are driven independently of the remaining rollers. Each pair is driven through spur reduction gearing from a 75 h.p. motor at the free side of the mill ; the remaining ten rollers on each side are lineshaft-driven through bevel gears. The main table frames are of heavy cast steel construction and, because of the difficulties which have been experienced in large blooming mills with bearing cap bolts on main tables, the seatings for the cartridges in which the bearings are fitted have been bored from the solid. On the drive side, where the thrust from the bevel gears is taken, the bore in the frame is large enough to thread the mill roller through. On this side the bearing cartridge is held in position by folding wedges.

The first shaping of blooms for the beam mill takes place in the blooming mill and roll changing is, therefore, a very much more frequent operation than in the usual blooming mill rolling rectangular blooms, where a pair of rolls may be expected to last several weeks. In this mill, therefore, rapid roll changing is effected by means of a duplex changing rig on the offside of the mill. A transverse sliding carriage, capable of carry-

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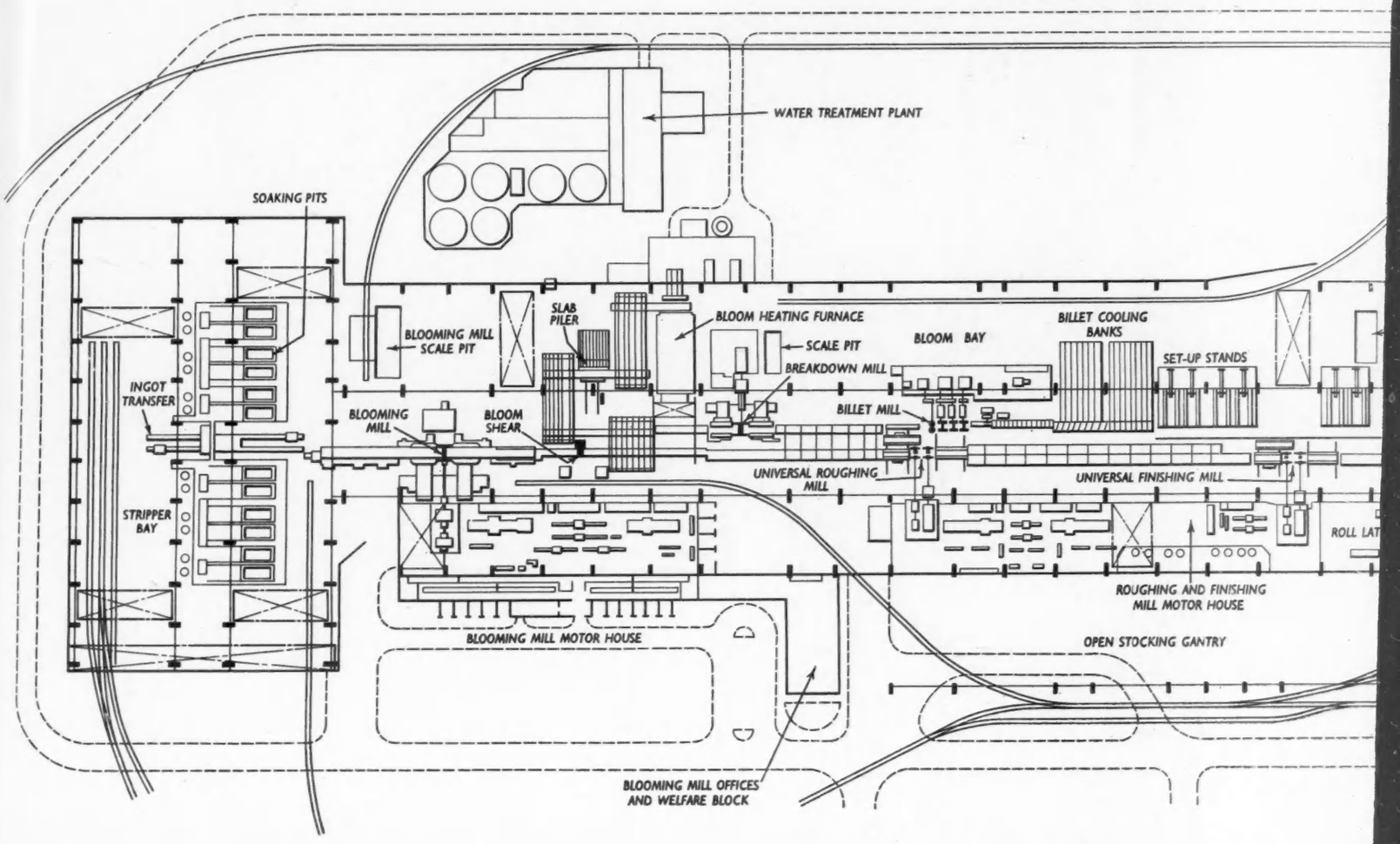
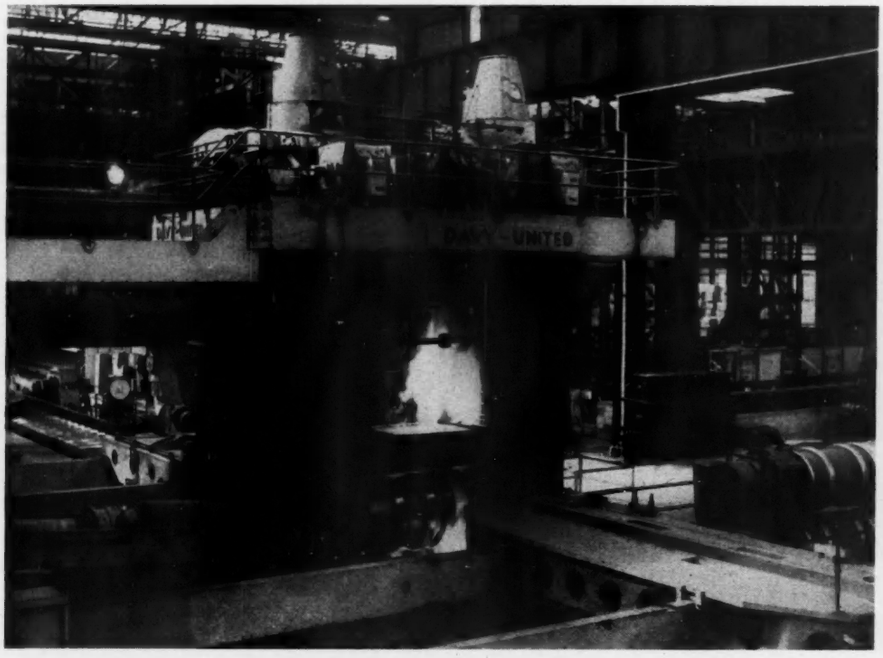
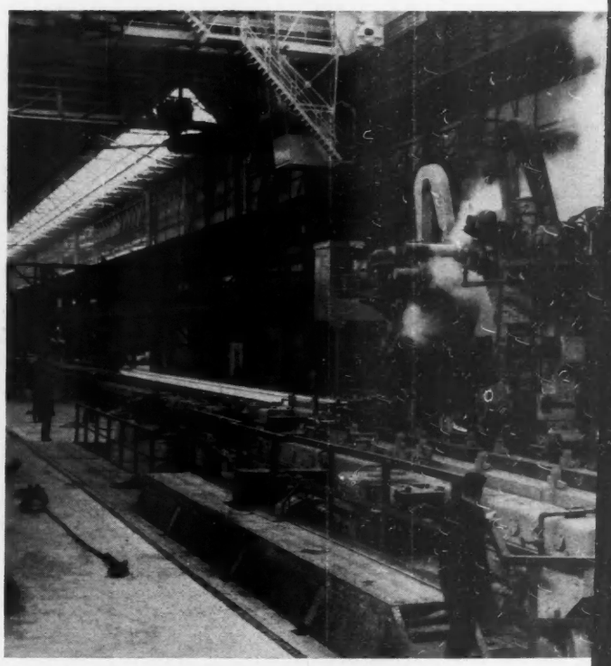


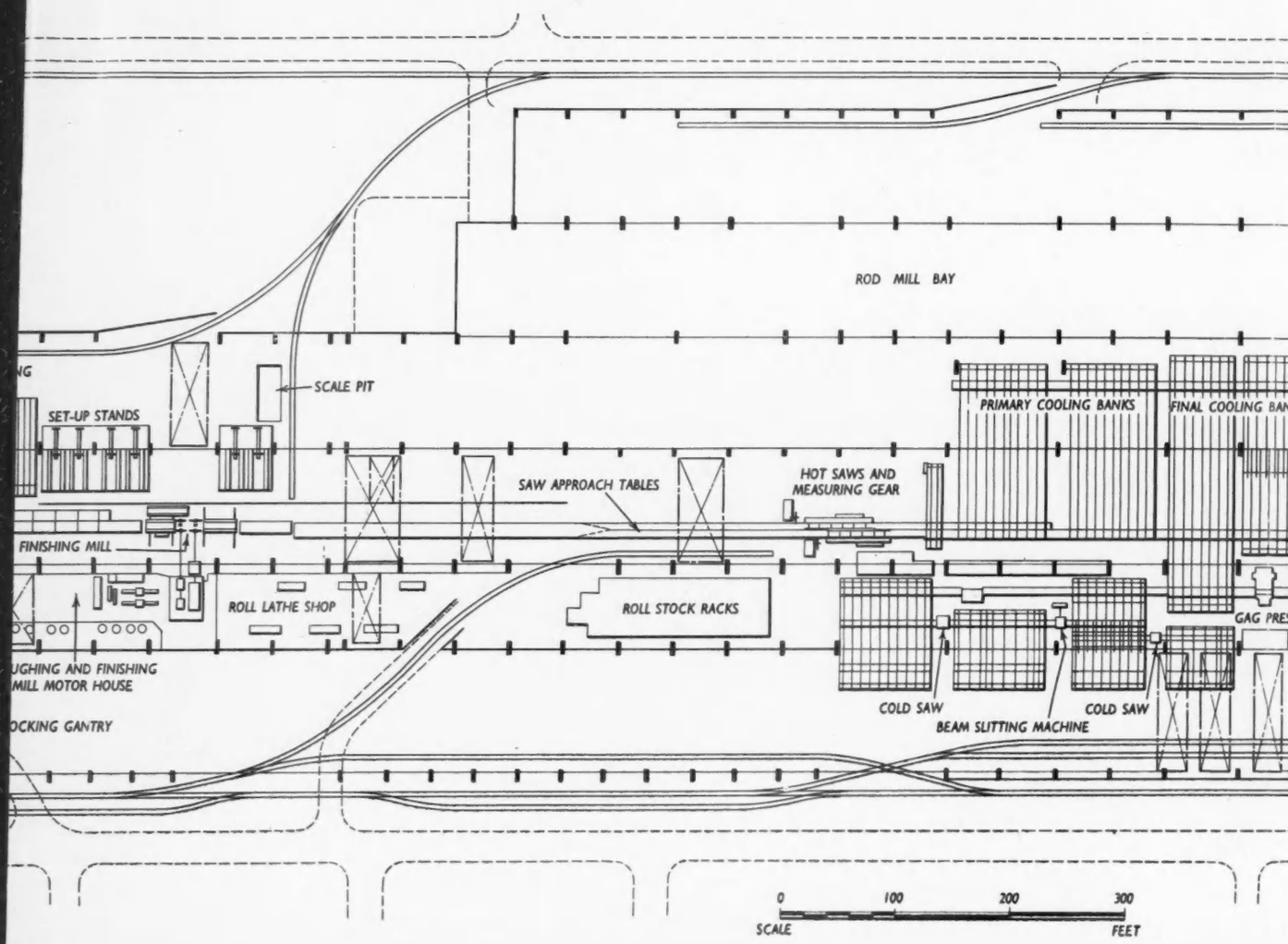


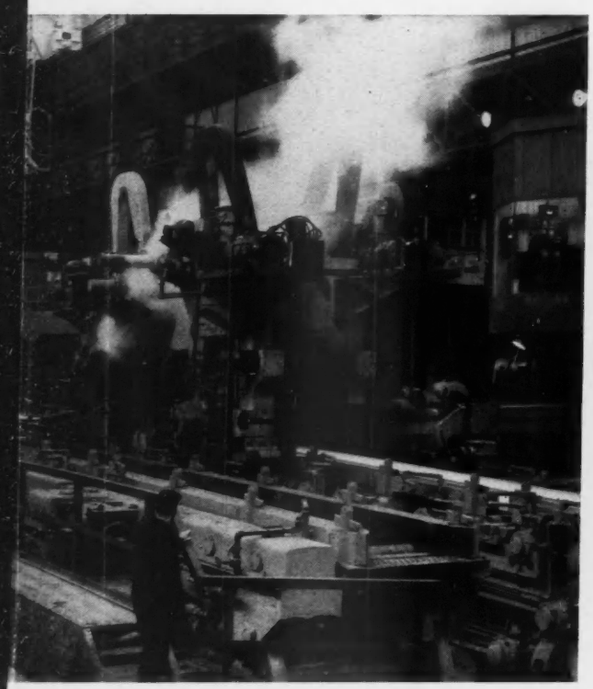
The blooming mill : to the right there is shown a pair of rolls made ready for the next change



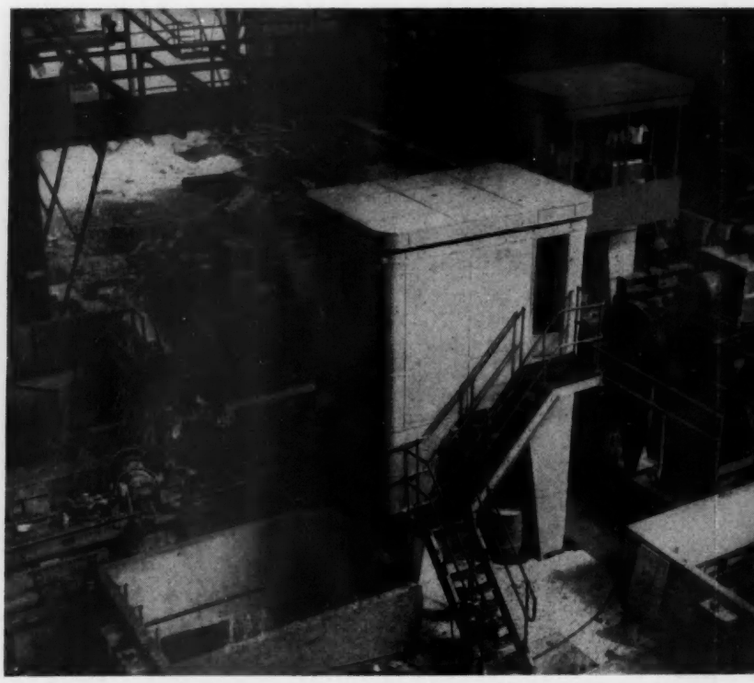
The universal finishing mill : a 36in by 16½in beam

UNIVERSAL BEAM MILL AT LACKENBY

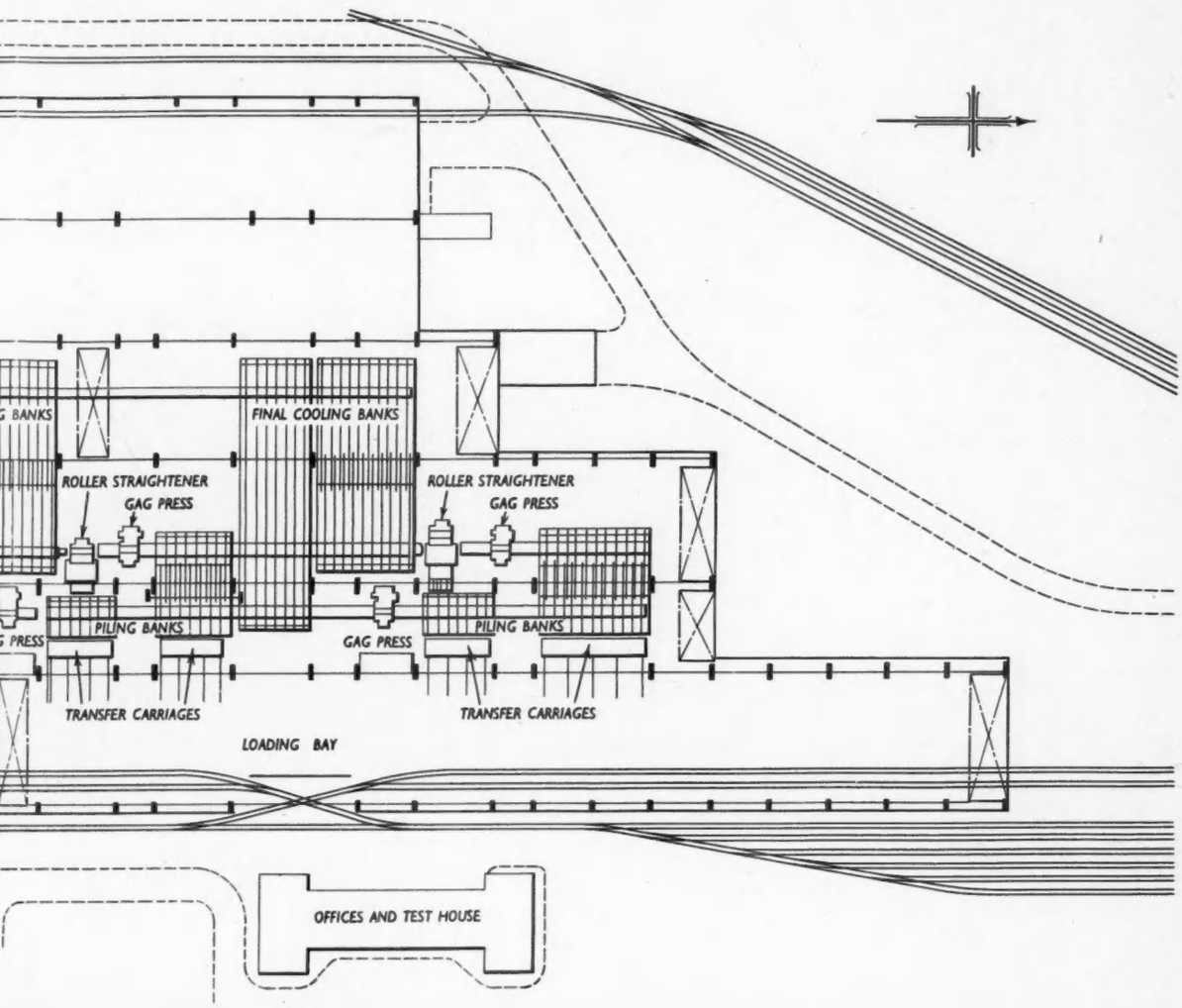




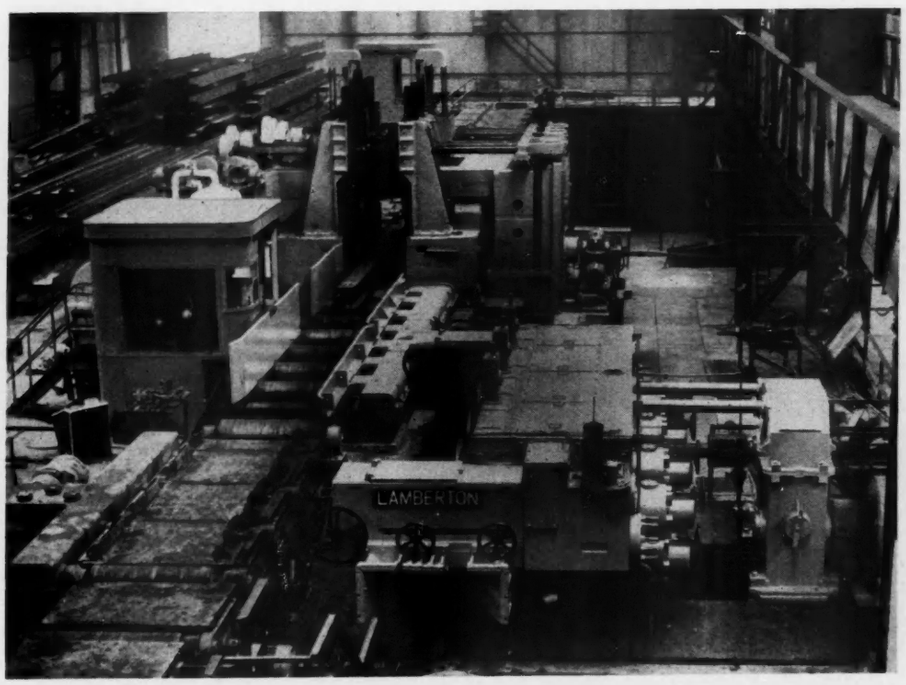
ng mill : a 36in by 16¼in beam is being rolled



The hot saws, with their control pulpits. There are two saws, 535ft and 560ft from the



the finishing mill



Reciprocating straightening machine, or gag press, with 14in by 16in column being straightened

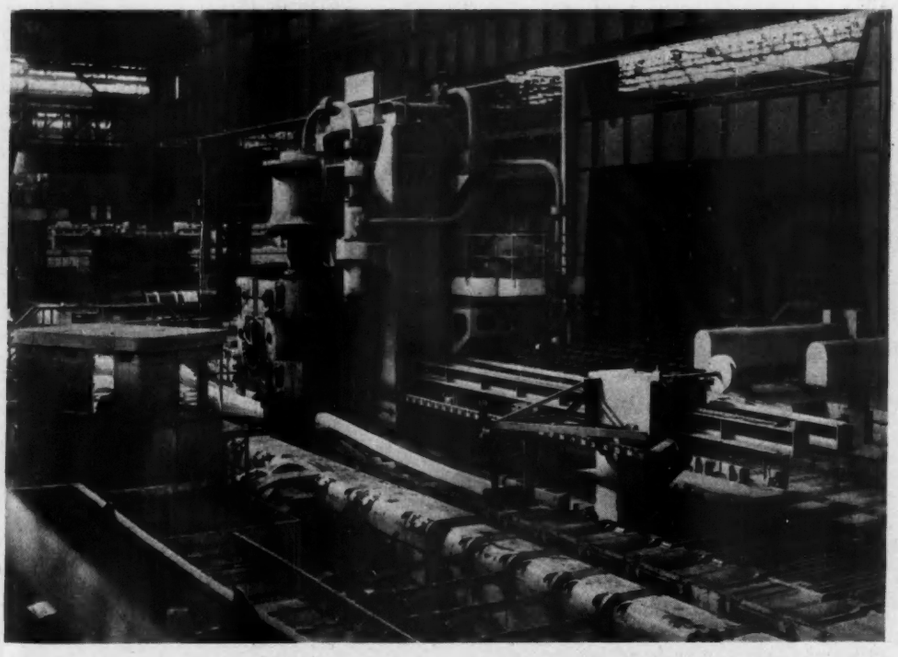
ing two complete assemblies of rolls and chocks, stands alongside the mill, and before a roll change takes place, a pair of new rolls complete with chocks on a sledge, is placed on the carriage. At the roll change, the old rolls and chocks are pulled out of the mill on their sledge by a beam with a hook, operated by rack and pinion by a 150 h.p. motor. When the old rolls are on the carriage, it is traversed by another 150 h.p. motor, with rack and pinion drive to the carriage, so as to bring the new roll assembly in line with the axis of the mill. The beam then pushes the new assembly on its sledge into place, and the old rolls can be taken away after the mill has again started work. The whole of this operation is under the control of one man standing at a control desk a few feet away. The engagement of the roll ends with the driving spindles has been simplified by placing an auxiliary control station on the drive-side mill housing, as close as possible to the point of engagement of roll and spindle. An operator placed here can take control of the movement of the roll change sledge and as he allows the sledge to creep inwards, he can inch the spindles up and down, by means of a small hydraulic valve for each spindle, until engagement has begun.

The outgoing side of the universal roughing mill, showing a 36in by 46½in beam being rolled. The large shackles are for lifting

Bloom and Slab Shear

The bloom and slab shear, 127ft away from the centre of the mill, is an opensided, hydraulically-operated, up-cutting machine, of 1350 tons capacity. Power is provided at a pressure of 2 tons per square inch by three triple ram pumps working in conjunction with an air loaded accumulator of 300 gallons available capacity. This combination enables the shear to make four cuts at full stroke in one and a half minutes, repeating after a lapse of one and a half minutes. The shear can cut slabs 10in thick and 50in wide, or equivalent areas up to 19½in thickness. The operating valve gear is pilot-operated from a push button in the shear control cabin. The shear consists essentially of two main parts, a C-shaped frame, which carries the bottom blade and the main hydraulic cutting cylinder, and the upper blade head, both being mounted in a fixed frame. The shearing force is entirely contained between the upper blade head, against which the hydraulic ram pushes, and the C frame. The C frame is a single steel casting weighing 145 tons. The upper head is adjustable to suit varying thicknesses of bloom, to avoid wasted stroke and lost time when cutting thin material. This head is supported by a pair of pivoted levers, which can be moved by screws, driven from a 75 h.p. motor.

The shaped blooms from the mill must be sheared in shaped blades, to avoid distortion of the cut ends, and must also be carefully guided into position on the blades. Motorised side guides on a tilting table are, therefore, fitted at the entry side of the shear, the position of the guides being indicated to the shear operator by a pointer on a dial driven from the guide motor by a synchronous tie motor. Particular attention has been given to blade changing which is necessary at every mill roll change. Each blade can be released by first slackening five nuts and then removing the blade on a special porter bar hung on the crane. Measuring of the length of the bloom to be cut is by a simple length gauge. On an overhead graduated beam a light motor-driven carriage runs, which carries a loosely swinging plate, with a pointer opposite the graduations. The bloom runs until its front end just touches the plate, the bloom is stopped, and the cut made. Crop disposal is simple. The front crop is pushed forward by the bloom to a point where a hinged roller can be lowered to make a gap allowing the crop to fall down a chute leading to the crop bucket. The back crop is pushed backwards, by reversing the movement of the bloom, to a gap between the ingoing table rollers, where it can fall down a second chute to a crop bucket at the ingoing side of the shear. Each of the chutes has a pivoted gate at the bottom, which can be lowered to hold up the crops while the bucket is being emptied.



Bloom shear and measuring gauge. The shear can cut slabs 10in thick and 50in wide

From the shear, there are several routes which can be taken by the bloom, depending upon its subsequent purpose. Shaped blooms for the largest of the universal beams, where the heat content relative to the radiating surface is sufficient to allow of the blooms being rolled into finished beams without reheating, will travel straight from the shear to the universal roughing mill, 330ft away. Smaller shaped blooms may be skidded sideways to a bloom bank, whence they can travel to the ingoing end of the 80 tons per hour bloom reheating furnace which takes blooms up to 28ft long. After reheating, each of these blooms is lifted by an overhead travelling finger crane, controlled from the operator's pulpit of the breakdown mill. This crane, when set in motion, picks up a bloom which has been discharged from the furnace, carries it to the roller table heading to the universal mill, and holds it suspended until the mill is free ; by operating a second switch the bloom is lowered and the crane

returns to its waiting position in front of the furnace. Rectangular blooms from the shear may go direct to the breakdown mill for the first stage of their reduction to standard sections such as angles and channels, or alternatively, they can be sent first to the reheating furnace, and then be lifted by the finger crane to the roller table leading to the breakdown mill. Those plain blooms destined for other of the company's mills are lifted off the bloom bank by one of the bloom handling cranes, and, when cold, loaded into wagons. The blooming mill also rolls slabs when required, and alongside the bloom bank a slab piler has been installed. The breakdown mill, in addition to providing the first reduction stage for standard sections, will also reduce blooms for subsequent rolling down in the four-stand billet mill, which produces billets and slabs for the production of rod, bar and strip in a mill now being built.

The Universal Mills

The two universal mills, roughing and finishing, are, of course, the essential components of the whole of the installation. Each mill consists, as all beam mills do, of two stands placed in tandem, the edging stand with its two horizontal rolls coming first, followed at a centre distance of 13ft by the main stand with two horizontal and two vertical rolls. The 53in diameter main rolls, when new, have a plain cylindrical barrel of a width to suit the distance inside the flanges of the beam being rolled. It should be explained that, with the four-roll method of rolling, beams with different flange and web thicknesses can be produced from the same rolls. The inner profile, fixed by the roll barrel width, remains constant and the flange and web thicknesses are varied by the distance apart of the horizontal and vertical rolls. The horizontal rolls are supported in bearings of phenolic resin-bonded fabric, lubricated by grease from an automatic pumping system and water sprays. Because of the need to provide room between the necks of the horizontal rolls for the chocks of the vertical rolls, the main roll bearings cannot be totally enclosed as they are in the two-roil stands, and the end thrust of the rolls is taken by fabric pads acting on the shoulder at the inner end of each neck.

In this kind of mill, where the flange edges are not controlled in the main stand, successful rolling is largely dependent upon maintaining the piece being rolled at the correct level relative to the roller tables. On the main stand, therefore, top and bottom screws have been provided, which bring the top and bottom rolls together between successive passes, while maintaining a constant pass level. The vertical rolls turn in roller bearings on a spindle fixed in a chock which slides on horizontal ledges cut in the housing window. To move the vertical rolls inwards as the flange of the beam is reduced in thickness, each roll chock is pushed by two screws housed in a yoke cast integral with the main roll housing between the horizontal roll necks. To prevent backlash, the vertical rolls are held against the screws by the side guides, which are pulled back by hydraulic pistons in cylinders mounted on the cross yoke. The mill driving spindles are retractable, so that they can be disengaged from the rolls when these have to be changed, the retracting gear comprising a hydraulic cylinder for each spindle, connected by levers and links to the spindle support bearing. As the spindle is pulled back, it brings with it the roll end coupling box, which is held supported on the spindle cradle in the correct position for re-engagement with the new roll. The drive to the main rolls is from a pinion housing, the top pinion being driven through a self-aligning internal tooth coupling from a single motor of 8000 h.p., with a base speed of 65 r.p.m. and a maximum of 165 r.p.m. and a torque of 1,615,000 lb ft at the base speed. The edging stand has two rolls, each 43in diameter. These run in fabric bearings in totally enclosed chocks and, as in the blooming mill, the end thrust is taken by a collar at the outer end of the offside neck running between two fabric pads in the chock. The driving spindles are generally similar to those on the main stand, with the same provision for withdrawal, but in this stand there are no driving pinions. The drive is direct from twin motors, each of 1350 h.p. at 125–310 r.p.m. and a maximum operating torque of 285,000 lb ft.

One novel feature of both the roughing and finishing mills is the arrangement of the side guides and the control of the positions of these guides relative to the positions of the horizontal and vertical rolls. It has already been explained that between successive passes of the beam being rolled, the four rolls on the main stand and the two on the edging stand must be brought closer together by a predetermined amount to give the correct reduction to the flanges and web, at the same time controlling the flange width and keeping the web central in the flanges. Equally important to good rolling is the guiding of the beam on to the rolls without the assistance which would have been given by tapered flanges, and to do this mechanically adjusted side guides have been provided. These are in two parts. The first of these guides are on each side of the vertical rolls and are pulled back against the rolls by hydraulic pressure. In addition, there are long guides running from the entry side of the edging stand, between the rolls, and almost up to the vertical roll guides. These long guides are moved by four screws, two to each guide, driven from a common motor, which is synchronised with the motor driving the vertical roll screws. Four dials indicate to the mill driver, sitting in his control pulpit at the side of the two stands, the positions of the rolls and guides. The two upper dials, one on each stand, record the horizontal rolls, while two inclined dials below his feet record the positions of the side guides and the vertical rolls. In addition to the indicating of the roll and guide positions by the dials, the two mills also have automatic preset positioning of three of these adjustments. The side guide adjustment is not preset, as it follows the adjustment of the vertical rolls. In this presetting equipment, two schedules, main and vernier, of the roll separation at each pass are set up for each of the three screw motions. On the roughing mill the steps provided in the main schedule are of 1in and in the vernier 0·05in ; the corresponding figures for the finishing mill are 0·25in and 0·01in. When the movement of one of the screw motors is started by a press button, the voltage output from a potential divider driven by a synchronous tie motor connected to the screw motor is compared electronically with the voltage from another potential divider, preset so that its voltage output is proportional to the required roll separation. The difference which is detected in the two voltages causes the screw motor to be driven in such a direction and by such an amount as to nullify this difference. The final position of the screw is determined by a cam limit switch, the final operational position of which is decided by a vernier potential divider comparing its voltage output with the vernier schedule. At any time between passes, the driver can cut out the presetting and operate the screws by hand control. Also, while the mill is working, a schedule can be set up for the next section to be rolled.

At the ingoing side of the edging stand and the outgoing side of the main stand, there are two short roller tables, of eight and ten rollers respectively, equipped with adjustable water-cooled side guards, and with a height adjustment at the mill end to suit the mill pass-line. These tables are mounted on electrically-driven carriages, so that they can be traversed sideways accurately to align each table with the centre line of the roll. This movement is necessary because the roll length varies with the section being rolled, and as the drive side housing is always in the same position to suit the main driving spindles, the centre line of the mill is variable. At a roll change these tables can be moved out of the way to leave a clear space for handling the roll stands. When the rolls have to be changed, the two stands, main and edging, are lifted out complete with rolls. The driving spindles are withdrawn, taking with them the roll driving boxes. All water, oil and grease pipes to the stand are disconnected, as are the electric cables. The stands are then lifted out by the two overhead travelling cranes, one of 275 tons capacity for the main stand, and one of 160 tons for the edging. For lifting, each stand is provided with two shackles, which can be manœuvred into the horns of the ramshorn hook of the crane by the driver without assistance.

The stands which have been lifted out of the mill positions are carried to an area opposite the finishing mill known as the "set-up stand area." Here, there are seven dummy mill beds on which complete roll stands can be placed. Prior to the roll change, spare stands have been set up on these beds with rolls for the new section to be rolled, and at the roll change, when the stands with the old rolls are brought in, the stands for the new section are ready to be carried immediately across to the mill. The stock of guides is kept in this area and can be fitted to the rolls as they are assembled. The whole of the area is serviced by a 15-ton travelling crane.

(*To be continued*)

Bar Steel Warehouse

Production in the bar mills of the English Steel Rolling Mills Corporation, Ltd., River Don Works, Sheffield, has been increased by modernisation to such an extent that facilities for the finishing processes and warehousing were found to be inadequate.

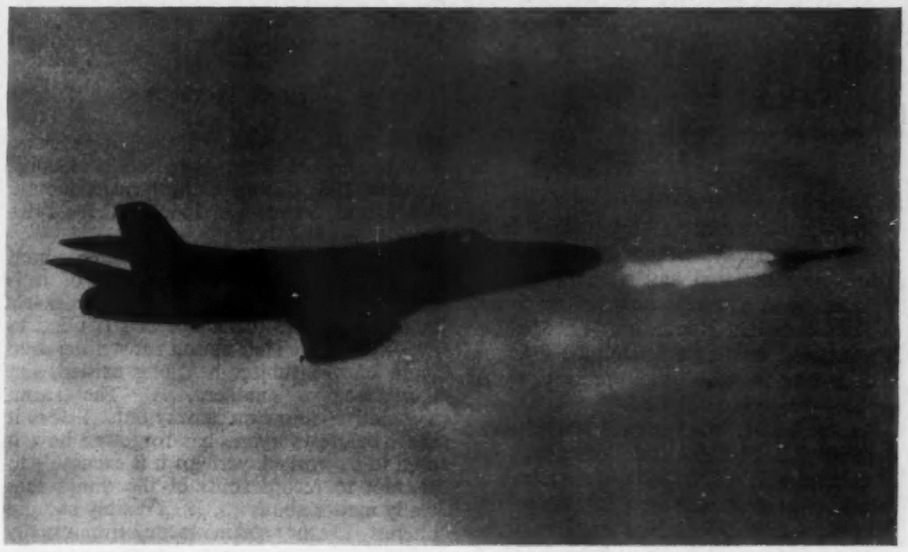
The warehouse has therefore been reorganised around a new method of handling, using side-operating fork lift carriers and a stacking procedure which makes use of the dead floor space between shop columns and at the gable ends of the bay which was not available to the overhead travelling cranes. The stacking racks, which were developed in conjunction with Tubewrights, Ltd., enable bundles of bars to be stacked by carriers in shelves up to a height of 10ft. Each rack has six shelves, the lower two accommodating 1½ tons each and the upper four, 3 tons each. Two "Irion" and one British "Kestrel" diesel-powered side-operating fork-lift carriers, each of 3 tons capacity, supplied by Materials Handling Equipment (Great Britain), Ltd., are used for stacking and carrying.

The machines in the warehouse have been fitted with special loading and unloading tables so that they can be fed with bundles of bars by the carriers, and it is now possible to run the warehouse without the use of the overhead travelling cranes, except for special operations and the loading of bars into wagons for despatch.

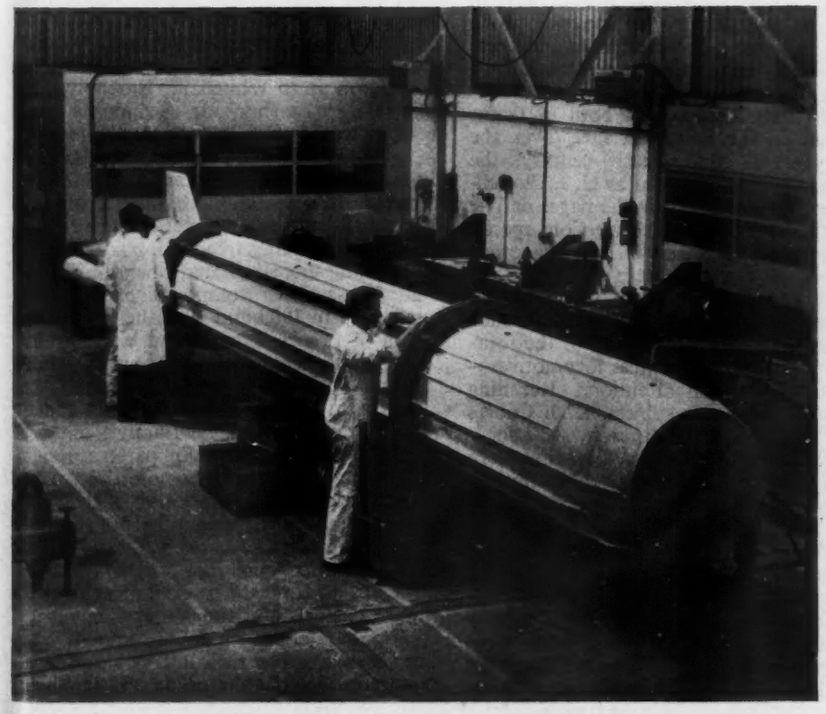
The carriers, each with a driver, are now doing the work of the four crane teams and the vehicles hitherto required to transfer materials from bay to bay.

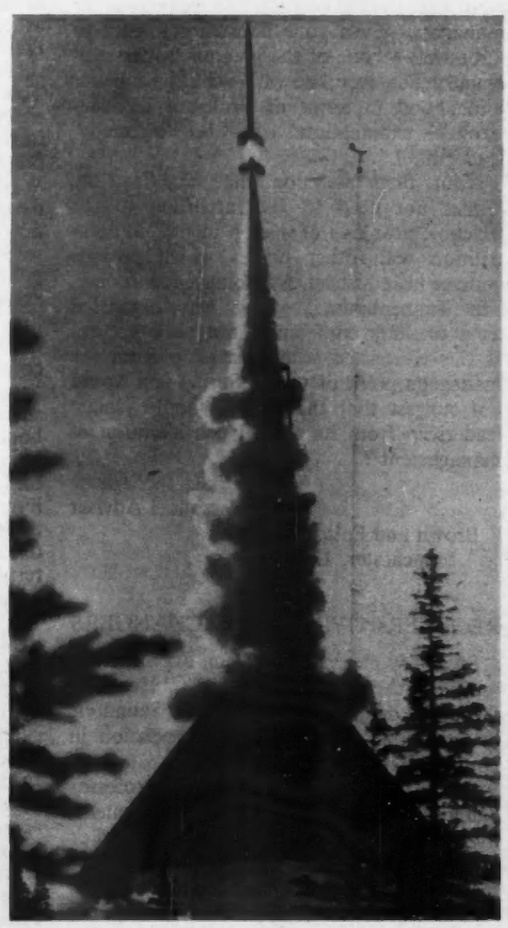
Rocket Propulsion Developments

In April, 1957, a Guided Weapons Development Squadron was formed at Royal Air Force Valley, near Holyhead, and equipped with Fairey "Fireflash" missiles. This weapon, which was illustrated on pages 228–229 on August 16 last year, is a beam-riding coasting vehicle which is accelerated to over Mach 2 by a pair of cordite-fuelled boosters, the nozzles of which are offset to spin the complete dart-booster assembly for stability: in the illustration RIGHT the vehicle has rolled so that the boosters are both in the plane of the camera. The beam is laid precisely as would be the guns of a cannon-fighter, by the pilot following the target with a gyro gunsight; a radar ranging equipment gives permission to fire. At the S.B.A.C. exhibition last month there was displayed an all-weather version, similar in appearance to the pilot-aimed weapon, which may be assumed to be guided by a radar beam locked on to the target. This system is used by the British ship-to-air missile, but this "Fireflash" variant is the only air-to-air weapon with radar homing, and, hence, all-weather capability, known to exist in this country: nevertheless, it does not appear that it will become operational. The limitation of the coasting missile is, clearly, that it demands a launcher with a high performance relative to the target: the after-burning Vickers-Supermarine "Swift" illustrated is the fastest fighter in the Royal Air Force, but it is out-performed by the attack aircraft of the Royal Navy, the same manufacturer's "Scimitar."



At the time that the "Fireflash" was initiated, solid propellants were regarded as suitable only to provide short impulses, the magnitude of which could be allowed to vary. In the intervening years development has changed this situation radically. Such techniques as bonding the charge to the case, so as to insulate the structure from the hot gases, have rendered the thrust/weight ratio of solid rockets competitive up to quite long burning times, and in the quest for high specific impulses fuels based on boron have been proposed which would accentuate the difficulties of feeding them to the chamber if they were not stored there in a solid dispersion. Already the solid rockets seem to have attained a performance adequate for military purposes, and it is probable that the de Havilland long-range ballistic missile will be the last such weapon to use a bi-propellant motor. The Aerojet-General Corporation of Azusa, California, who engine the "Polaris" and are contributing to the "Minuteman," the multi-stage weapon for tactical, intermediate range or inter-Continental missions, have now joined with the Bristol Aeroplane Company, Ltd., to form a subsidiary company in England known as Bristol-Aerojet, Ltd.: the board will include the chairman and the general manager of Bristol Aircraft, Ltd., the subsidiary at present responsible for solid rocket motors. The new firm will include in its activities propellant formulation, a branch of basic research so expensive that many of the United States chemical manufacturers have been seen to combine to support it. One of the best known products of Aerojet-General is the "Aerobee-Hi" research rocket, seen RIGHT, with the solid booster smoking and the liquid sustainer flaming: the building surrounding the foot of the launching tower is necessitated by the climate, this being a firing from Fort Churchill, Canada, during the International Geophysical Year.





While immense increases in performance over the early Walter and de Havilland hydrogen-peroxide motors are now possible, they can only be achieved by expensive development programmes. Thus, the Saunders-Roe "Black Knight" experimental rocket, of which only small numbers will be built, has four hydrogen-peroxide-kerosene motors. These Armstrong-Siddeley units are gimballed for control of the flight path, a system that has probably been adopted because it is established practice in the United States and, therefore, on the Rolls-Royce motors, so that the equipment needed is available in this country. The use of these mild propellants renders it possible to build the vehicle from conventional aircraft materials, and the flight programme, dominated by weight rather than drag, allows the fuel pipes and even stiffeners for the cylindrical shell to lie outside, as can be seen LEFT.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

B.I.M. AND PSYCHOLOGY

SIR,—In a recent editorial you doubt whether the British Institute of Management "does its reputation any good at all" by the promotion of conferences similar to that at the Connaught Rooms on "Leadership." My impression is that few of the directors and managers who were present would support your criticism.

As the B.I.M. handles over 700 inquiries per annum in the human relations field (some of them almost to the point of management consultancy) obviously there exists a general interest in leadership which busy executives want satisfying. In Professor Tannenbaum, the B.I.M. sponsored a "practical" authority who has studied widely the behaviour of managers. Even your unusual reference to Cromwell—"one of the greatest leaders this country has ever known"—could be better understood in terms of Professor Tannenbaum's explanation of "boss-directed" leadership!

Your final assertion that the Institute "does not need to give attention to the psychological side of management" in competition with other bodies which provide courses in industrial psychology, is puzzling. The Tannenbaum meeting was organised as a one-day conference, not as a course. It was concerned with leadership from the manager's point of view. Surely you would not suggest that the B.I.M. should isolate leadership from its overall consideration of management?

R. B. STOKES,
Personnel Adviser

Brown and Polson, Ltd.,
Manchester, 17.

REGENERATIVE HEAT EXCHANGERS

SIR,—My attention has been drawn to the reprint of the presidential address "Heat and the Engineer," by Professor O. A. Saunders, to Section G of the British Association in your issue of September 12.

In a section of this article Professor Saunders implies that the idea of a regenerative heat exchanger, employing either fixed or rotating matrices, is comparatively new and that little practical use has been made of this type of heat exchanger. In fact, this company has been engaged in the development and manufacture of rotary regenerative heat exchangers for over thirty years, and these have found widespread application, throughout the world, for the recovery of heat from the waste gases of water-tube boiler installations up to the largest sizes.

J. E. SAYERS,
Chief Engineer

James Howden and Co., Ltd.,
195, Scotland Street,
Glasgow,
October 8, 1958.

Book Reviews

Great Western Steam. By W. A. TUPLIN, D.Sc., M.I.Mech.E., A.I.Loco.E. George Allen and Unwin, Ltd., Ruskin House, Museum Street, London, W.C.1. Price 25s.

"MUCH has been said and written about Great Western engines, but a lot of it is misleading in its idolatry, for Swindon exacts in some devotees a homage that is blind to imperfections. That reason for writing even more on the subject has long existed, but there is now another..... The steam locomotive is now on its way out. Before it goes, before everyone has forgotten how it used to be worked, perhaps it is excusable to attempt to record some of the things that really matter about it.... Possibly because interest in the steam locomotive usually starts in infancy, much literature on the subject gives the reader barley sugar instead of the more appropriate coal-dust, soot and ashes, but at this stage in railway history there is perhaps room for a realistic record that adults at least should not find too strong. The enthusiast may be glad to read here expressions of admiration for what they are, in the last resort, mere pieces of machinery, but he will find the dashing prowess of Great Western locomotives explained by intelligent design, careful building, hard driving and hot firing, and not humbly attributed to some wonderful Wiltshire witchcraft."

These quotations from the author's preface explain his reason for writing. At the same time they will prepare the intending reader for the manner of the writing, if he is not already conversant with the author's previous utterances, either verbal or written, on the general subject of locomotive engineering. This book on Great Western locomotive practice as initiated by G. J. Churchward and carried on by his successors, C. B. Collett and, after him, F. W. Hawksworth, the last of the Swindon Chieftains, tells the story in a distinctly original manner and in certain respects is refreshingly outspoken, which adds to its value; however, here and there will still be found a little "barley sugar."

Much has already been written about Great Western locomotives, both in recent times and in the past. In fact, over the earlier years of the present century, the successive developments due to G. J. Churchward were fully recorded in the pages of THE ENGINEER, and in this connection special mention may be made of an historical account of the Great Western Railway in the form of a supplement to the issue of December 16, 1910, with which was included complete arrangement drawings of the four-cylinder "Star" class express locomotives—then attracting much attention. Recalling later references to this subject, K. J. Cook's paper, "The late G. J. Churchward's locomotive development on the Great Western Railway," communicated to the Institution of Locomotive Engineers, 1950, and "An Outline of Great Western Locomotive Practice, 1837–1947," by H. Holcroft, recently published, deserve special mention.

In reading the new book, it seems clear that the author has made himself fully acquainted with both these reviews of Swindon practice. At a very early age the author became attracted by Great Western engines, and reading accounts of their performance in later years seems to have awakened an interest in, and some admiration for, Swindon-built locomotives, and the present book would therefore seem to be the result. Writing of Churchward's work in developing his remarkable line of standard designs, it is said that he, Churchward, realised "his job was to give the Great Western reliable locomotives with the least risk of trouble for himself and that demanded that he should use no device or design that had not already been thoroughly tested by somebody or other." No doubt students of steam locomotive engineering and of Great Western practice in particular will agree that, in the main, this statement would seem correct. But simply copying other people's work without regard to all the circumstances of the application, whatever it may be, can lead at times to unsatisfactory results, which was apparently the case when Swindon design practice was first introduced on the L.M.S. Railway, where it seems to have left something to be desired. The main part of the book is devoted to certain of Churchward's designs individually and others introduced later and in some cases the author suggests alternative designs, thus adding interest to his remarks.

In order to indicate the scope of this book, the following is a list of the principal subheadings: "Some Famous Swindon Designs," "Some Constructional Features," "Some Great Western Running," "Locomotive Exchanges," "On the Footplate" and "Some Footplate Journeys." The last-named is treated in an unconventional manner, and intending readers will be able to form some idea of what to expect if an article published in THE ENGINEER of March 10, 1955, can be brought to mind. This was entitled "Reports from the Footplate." The descriptions given concerning footplate experiences reveal much of interest, including a story of how the "Jumper top" of the blast pipe on a "Star" class engine was wedged down to induce the boiler to "steam" with inferior coal, and a fairly heavy train when being "assisted" from Wellington up to Whiteball. Probably some readers may be shocked. Swindon boilers, were, it would seem, somewhat "choosey" as to the quality of coal they wanted. In discussing Swindon practice following Churchward's accession to the Locomotive Superintendent's chair, American features are mentioned as being freely adopted and with outstanding success. Later, when the French-built four-cylinder compound engines were introduced in 1903 and 1905, he became "a victim of French allure" and built the first four-cylinder engine No. 40, later named "North Star." The author devotes some attention to this design, which comes under a rapid fire of criticism. Certainly it must be agreed that the inside motion parts, especially the valve gear, were very inaccessible, partly because of the forward position of the inside pair of cylinders resulting in part of the valve gear being under the smokebox. The outside cylinders also were not well positioned, especially with regard to clearances with the running gauge, and the steam and exhaust connections left much to be desired. The French engines had their h.p. cylinders in the same position, but the inside l.p. pair being

directly under the smokebox, central between the wheels of the leading bogie, were much better placed ; not only did they not interfere with the leading wheels of the bogie when displaced on account of curves in track, but also the inside motion was much more accessible.

Mention may be made of a description with arrangement drawings of the de-Glehn four-cylinder, compound engines as used on the Paris–Orleans Railway, published in THE ENGINEER of June 3, 1904, which with those of the Churchward " Star " class given in the issue of December 16, 1910, will show the differences between the two cylinder arrangements. The author discusses this Swindon design, exemplified by No. 40, making a comparison with the L.N.W.R. " Claughton " four-cylinder engines, which, it may be remembered, had all four cylinders in line, two outside and two inside under the smokebox, the drive being taken by the leading coupled axle, which, with outside valve gear, produced some improvements. However, the author goes on to say : " But even awkward constructions can be made to work if enough care and attention is given to them and, in spite of having features which must be regarded as serious imperfections, the design of No. 40 was taken as a model for all Swindon four-cylinder engines, some of which were being built over forty years later."

Under the general sub-heading " Some Constructional Features," cabs and cab fittings are discussed, including a reference to the experimental application of a mechanical stoker in 1904. The engines concerned are stated to have been No. 3346, one of the " Bulldog " class, from which it was later transferred to one of the " Atbara " class, No. 3380. In view of the experiments now being made with the mechanical stoker fitted to B.R. standard 2–10–0 engines, it is of interest to recall this earlier application. Other subjects mentioned include cab signalling, used for many years past on the G.W.R., and reference is made to the " very expensive system " now being introduced by British Railways. The Swindon test plant and road testing are some of the other subjects noted.

Throughout the book there is a selection of forty-four well-produced illustrations and drawings, which are a valuable addition to the text, which, with tables of dimensions and performance data with an index for ready reference, extends over some 194 pages. There is a wealth of detailed information on Swindon-built locomotives, collected together and presented in an interesting and, we may perhaps dare to say, in some instances, a rather amusing manner by a well-known mechanical engineer of high professional attainments.

Men and Machines. By CHARLES WILSON and WILLIAM READER. Weidenfeld and Nicolson, 7, Cork Street, London, W.1. Price 35s.

THE dichotomy on the title page of this volume is interrupted by the sub-title *A History of D. Napier and Son, Engineers, Ltd.*, 1808–1958. Thus in the period which it covers there occurred the growth of the engineering industry in this country, as is emphasised when we read that in 1808 David Napier spent some time in the works of Henry Maudslay, before setting up on his own in Lloyds Court, St. Giles. The firm has, then, progressed through an environment changing strongly and rapidly, and the authors have not attempted to describe in detail how developments without have influenced it, perhaps discreetly in view of the fact that they have occupied 180 pages as it is. For those with a knowledge of the period, however, this forms a very readable and entertaining account of a family of exceedingly gifted mechanical engineers, each with a personality that imposed a distinctive, if not a financially very successful, policy upon the firm. It is particularly interesting to see how the desire to build machinery of extreme quality led to dependence on a continually decreasing number of customers to whom cost was a subordinate consideration.

The engineer, however, will feel that this account often does less than justice to the creations of the firm. For instance, it is said that " Montague Napier's engine of 1899—the first in a long series of Napier motor engines for cars, boats and aircraft—was a two-cylinder vertical engine of about 8 h.p. The cylinders fired one after the other, but the cranks went round together, so that there were two firing strokes followed by two strokes when neither cylinder fired "—an extraordinary description to have been prepared at a time when the chatter of the parallel twin four-stroke is to be heard throughout the land. Perhaps more insidiously misleading is the description given of the relations between the Air Ministry and the firms carrying out aero-engine design and development : " there were the strongest possible reasons why they (D. Napier and Son, Ltd.) should never gamble on what this customer or any other might want . . . " In fact, when in 1925 the Ministry wanted a copy of the monobloc Curtiss D-12 to be built for Fairey, the Napier design had not only separate cylinders, like the " Lion," but also separate heads. Rolls-Royce, Ltd., was perfectly ready to acknowledge that French and United States principles had proved superior to its own, and evolved the " Falcon X " or " F-X " into the " Kestrel." The result was that at the death of the third Napier to control the business—in January 1931—the business of aero-engine manufacture seemed unlikely to sustain the firm.

An earnest attempt is made to describe the policy, or rather policies, of the Board at what we can now see as a moment when the firm was a in a position—having very large capital assets—to affect the course of history. But the excessive concentration on the one firm distorts the story as it appears in the pages. The firm offered, finally, £104,775 for the assets of Bentley Motors, Ltd., but was outbid. The authors quote without comment the remark of the general manager, F. A. Davies : " I have little doubt that this is evidence that the Rolls-Royce Administration were of opinion that this Company would be a competitor of some importance." This view is supported by the recorded words of Sir Henry Royce : " I believe you're a commercial man, Mr. Bentley ? "

But is it reasonable to believe that £125,625 were offered in such a state of ignorance ? And the validity of the present text is the more suspect when we find the titles of both Bentley Motors, Ltd., and Scammell Lorries, Ltd., corrupted.

As entertainment rather than a work of reference this volume has great merit particularly those chapters covering the lifetimes, of David, James Murdoch, and Montague Stanley Napier. The authors are by no means overawed by their subjects, as witness the following :

" Napier, though on hand for mechanical emergencies, did not himself travel on the car : this set the general pattern for his future co-operation with Edge in the latter's feats of driving."

Principles of Electronics. By RUSSELL H. KRACKHARDT. The Ronald Press Company, 15, East 26th Street, New York 10, N.Y. Price 7.50 dollars.

THE preface states : " The purpose of the text is to set forth the basic principles which underlie all elaborate systems. It concentrates on topics which are of immediate concern to the beginning student, and devotes considerable space to clear descriptions of topics which he often finds difficult to grasp." We consider that the author has fulfilled competently the task which he set himself. He has been prepared to discuss at length fundamental ideas and not merely to state them in words or equations. He has dealt with a few circuits at length, rather than treat a large number superficially.

The book deals first with electron emission, simple examples of electron motion and space charge. Rectifier circuits are then discussed, followed by a treatment of the properties of triodes and multi-grid valves and their use as amplifiers. An account, on an elementary level, of the properties of semi-conductors and their use in junction diodes and transistors, follows. Rather surprisingly, the author then reverts to a discussion of gas-filled valves and concludes with a chapter on photo-electric transducers. The difficult subject of semi-conductor behaviour does not seem so clearly or convincingly discussed as the valve phenomena, and the curves dealing with intrinsic conduction in germanium do not appear to be correct. The book would have been more complete if one sinusoidal, oscillator circuit and one pulse-generating circuit had been dealt with in the same detailed manner as the rectifier and amplifier.

It is good to see a general textbook of electronics which includes transistors. The treatment of valve circuits does not include anything which is not adequately set forth in a number of British books. This book is well produced and we detected only one misprint and that not of a kind to mislead. Rationalised M.K.S. units and standard symbols are used, though small letters for amperes, volts and farads look strange to British readers.

Books Received

Pratique de la Mesure et du Controle dans l'Industrie. By J. Burton. Dunod, 92, Rue Bonaparte, Paris (6eme), France. Price Fr.4.400

Directory of Railway Officials and Year Book, 1958–1959. Tothill Press, Ltd., 33, Tothill Street, Westminster, London, S.W.1. Price 40s.

Lubrication Science and Technology. Edited by John Boyd. Pergamon Press, Ltd., 4 and 5, Fitzroy Square, London, W.1. Price 105s.

Thermodynamik. 7th Edition. By E. Schmidt. Springer-Verlag, Reichpietschufer 20, Berlin W. 35, Western Germany. Price DM.30.

Aircraft and Missile Propulsion. Vol. 1. By M. J. Zucrow. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 92s.

Heat Exchangers. By W. Hryniszak. Butterworths Scientific Publications, Ltd., 4 and 5, Bell Yard, London, W.C.2. Price 63s.

Missile Engineering Handbook. By C. W. Besserer. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 109s.

Mechanics Applied to Engineering. By G. H. Ryder. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 21s.

Engineering Vibrations. By L. S. Jacobsen and R. S. Ayre. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 77s. 6d.

Sales and Engineering Representation. By Lee O. Thayer and George E. Harris. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 46s. 6d.

Composite Construction in Steel and Concrete. By I. M. Viest, R. S. Fountain and R. C. Singleton. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 58s.

The prototype C.F.-105 "Arrow," with two "J-75" engines, landing after a test flight. The chase aircraft is a C.F.-100 "Canuck" with the wingtip weapon pods removed. The perforated part of the intake ramp and the corresponding external extractor can be seen

All-Weather Interceptor

By J. C. FLOYD, A.M.C.T., P.ENG., F.R.Ae.S., F.C.A.I., M.I.Ae.S.*

The fourteenth British Commonwealth Lecture to the Royal Aeronautical Society was delivered on Thursday last week. We abstract parts of the text dealing with the Avro C.F.-105 "Arrow" supersonic interceptor.

THE R.C.A.F. had established a requirement for a two-place, twin-engined aircraft. Their preference for a crew of two was partly based on the complexity of the newer fire control systems, and the fact that, while the chosen system was intended to be entirely automatic during the mid-course and terminal phases of the attack, it was the intention to press home an attack on the basis of a manual mode, in the event of the failure of the automatic mode.

The choice of two engines was based on a combination of circumstances, the advantages of two engines being obvious in reduced attrition especially during training. One of the most important factors, however, was the fact that with the very large weapon package required as payload, and the large amount of fuel carried for the range requirements, the size of the aircraft was obviously going to be such that there was no single engine large enough to power it.

Our choice of a tailless delta was based mainly on the compromise of attempting to achieve structural and aeroelastic efficiency, with a very thin wing, and yet, at the same time, achieving the large internal fuel capacity required for the specified range.

This established our delta planform, and the lack of a tail can be attributed almost entirely to our desire not to have to face the problem of putting a tail on top of an extremely thin fin out of the effects of wing downwash, or, otherwise, having to put it so low, again out of the downwash region, that our landing angles would be impossible. We felt that the problems associated with a tailless delta were more predictable and manageable.

We were also very conscious of the problems that tailed deltas were having at that time, where a large increase in downwash at the stall made the tail strongly destabilising, so that the stalling characteristics became objectionable.

It was obvious from the outset that to give the R.C.A.F. an aircraft with flexibility of development, the aerodynamic characteristics should be such that they would not limit the speed to less than the structural limitations. The aluminium alloy structure which we favoured was good for speeds in excess of Mach 2, and we therefore felt that our aerodynamics should be at least as good as this.

To achieve this we had to go to the thinnest possible t/c ratio, and started out with a 3 per cent t/c wing throughout the span ; however, aileron reversal forced us to go to a thicker and stiffer wing section, and we compromised at 3·5 per cent at the wing root, and 3·8 per cent at the tip. The structural advantages of the delta made the achievement of a thin wing section possible without a large weight penalty.

So for us, the tailless delta had distinct virtues, with the added advantage that Avro Manchester had, by that time, done considerable flying with the delta research aircraft 707s, prior to the design of the Vulcan tailless delta bomber, and this information was, of course, available to us.

However, the delta, like everything else, also had its vices. For instance, aeroelastics were obviously to play a very big part in our design, due to the extremely thin wing and fin sections, and, in calculating the aeroelastic and flutter characteristics of a delta wing the standard semi-empirical methods of analysis would have produced a prohibitively heavy structure if we had used them indiscriminately. We had to examine all types of aeroelastic and flutter problems from first principles, and we repeated these as the design progressed. The establishment of the structural matrix was a very laborious process, most of which had to be done on our digital computers.

Due to the short elevator arm we were, of course, in trouble with trim drag. The high elevator angles required to trim at high altitude increases the elevator drag considerably. We investigated means of reducing this, and the most promising appeared to be the introduction of negative wing camber. Camber has the effect of building in some elevator angle without the excessive control surface drag. The amount of camber chosen, which was $\frac{1}{4}$ per cent negative, was that which would give a good compromise between the positive angles to trim at low altitude, and the negative angles required at high altitude.

Leading Edge Notch and Extension.—Early in the design stages we made modifications to our original clean wing. These were the addition of leading edge droop, and the semi-span notch with outer wing chord extension. These modifications were made as a result of wind tunnel tests, carried out at Cornell Laboratories in Buffalo on a 3 per cent complete model, sting mounted. The approximate Reynolds number used during the tests was between 1,000,000 and 2,000,000. These tests showed that we were getting a pitch-up or non-linearity in the C_M–α curve at moderate angles of attack. This phenomenon is not peculiar to deltas, being common to all swept wing aircraft. In flight it could cause a tightening in the turn.

Crudely, the condition appears to be caused by vortices which start at the tip and move to the apex of the swept wing. Low-pressure air is collected from the fuselage and causes a breakaway outboard of the area covered by the vortex, which is mainly at the trailing edge. This causes the effective aerodynamic centre to shift forward, giving a "pitch-up" or an abrupt change in the moment curve.

While the pitch-up appeared on test to be of small magnitude, since very moderate amounts of pitch-up can be embarrassing to the pilot, we attempted to eliminate it.

We were aware of the work that had been done by N.A.C.A. and the R.A.E., and the fact that a number of other aircraft which had exhibited this tendency, had used either notches in the leading edge at about semi-span, or extensions of the wing leading edge outboard, in an attempt to prevent the flow separation. The notch had been used, for instance, on the English Electric F 23, and the leading edge extension had been installed on a Grumman F9F9, and a Chance Vought aircraft. The notch has a somewhat similar effect to a fence and causes the disturbing vortices to move away from the apex of the swept wing toward the notch, which is at semi-span, and reduces the area of disturbed flow over the wing. The notch, however, produces these effects by air flow rather than as a physical barrier. It was our opinon that the effects of the notch are present over the whole speed range, whereas a fence is usually only effective over smaller speed ranges, and the notch was expected to increase the drag by a lesser amount than a fence.

We did find, however, in our tests that with the notch alone the test results were not repeatable ; in other words, we could not get the same results in subsequent tests. When we installed the leading edge extension in addition to the notch the results were far more repeatable. We tried eight different notches and three extended leading edges

* Avro Aircraft, Ltd., Malton, Canada.

in various combinations. The depth of the notch appeared to be the most critical parameter, and here again we had to bear in mind that we could not have too deep a notch because of the structural problems.

(Plate 10, January 10 last, shows the 5 per cent notch and 10 per cent extension of the local chord on the outer wing.)

Drooping of Leading Edge.—During the time that the tests were being carried out on the notch and leading edge extension for pitch-up, we were following very closely the work being done on the F.102 with regard to a reduction in induced drag by drooping the wing leading edge, and also the work that was going on at Avro Manchester on the "Vulcan." They were drooping the leading edge to increase the buffet boundary by preventing leading edge breakaway at high angles of attack.

This also influenced us in choosing the 10 per cent increase in leading edge outboard, to cure pitch-up, since we realised that, if after investigation we found that it would be advantageous to droop the leading edge, the extension would increase the amount of effective droop.

We installed droop on the wind tunnel model 8 deg. inboard and approximately 4 deg. outboard. This increased the buffet boundary considerably. For instance, at Mach 0·925, which is the normal subsonic cruise Mach number, the C_L at which we estimate the onset of buffet is increased from 0·26 with the extension alone, to 0·41 with the extension plus droop. The buffet, or flow separation, was indicated by pressure plots on the ailerons in the Cornell Laboratory tunnel tests. The supersonic drag did not appear to be increased appreciably.

We were also cognisant at this time of the work on vortex generators which Avro Manchester were doing for alleviating the shock-induced rear separation, but from the evidence we had from N.A.C.A., and also from the Manchester reports, it was felt that for a t/c ratio of under 5 per cent this would not be a problem, and we would not require to use vortex generators for this reason on the C.F.-105.

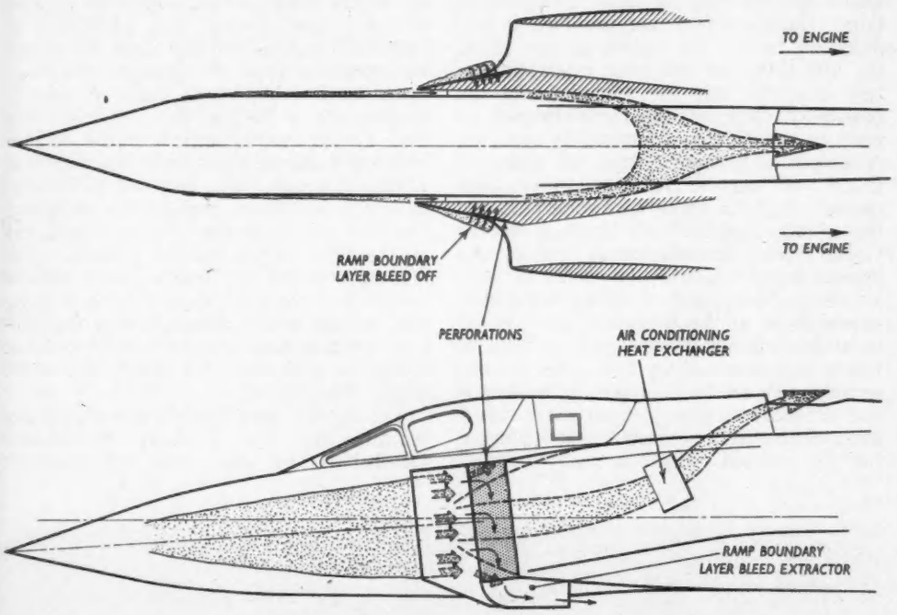
Anhedral.—Another peculiarity of the C.F.-105 wing is the 4 deg. anhedral. This was established entirely to reduce the length of the undercarriage, and has no appreciable aerodynamic effect or significance.

High Wing.—We went to a high wing arrangement because of the greater flexibility with this layout. For example, it allowed us to have a relatively simple engine installation, and any changes in engines and armament can be made without affecting the basic wing structure, which is not always the case with an integrated wing-fuselage structure.

It also allowed us to carry the wing structure straight through without a break at the fuselage, and simplified the wing to fin attachment, since there was no necessity to carry the fin structure down through the engines. The fin is 4 per cent t/c.

(Mr. Floyd then explained the application of area rule to the "Arrow": at speeds above Mach 1 the rule applies, not to cross-sectional area, but to the area intersecting a plane tangential to the Mach cone. For bodies other than solids of revolution a large number of such planes need to be considered and the areas integrated over 2π.)

We made up eleven plastics models at one-thirtieth scale and cuts were taken on these to represent various Mach numbers. The cuts were then checked on a planimeter, the results fed into a digital computer, and plots were made around the aircraft at 0 deg., 45 deg., 90 deg., 135 deg. and 180 deg. Most of the results were obtained around Mach 1·5, and as a result of this extensive investigation we sharpened the radar nose, thinned down the intake lips, reduced the cross-section area of the fuselage below the canopy, and added an extension fairing at the rear, to smooth out the bumps in the area rule curve.



Intake geometry of the Avro "Arrow"

Air Intake.—The arrangement of the intakes is shown in the diagram and consists of basically the following:

(*a*) A boundary layer bleed, which diverts two-thirds of the air in the boundary layer over the top and bottom of the wing, the middle third being taken into the heat exchangers in the air conditioning system.

(*b*) The intake ramp, which is used to create an oblique shock wave at supersonic speeds to allow optimum pressure recovery characteristics inside the intake, and which, combined with the normal standing shock, prevents turbulent conditions in the intake over most of the Mach range.

The optimum angle for the fixed intake ramp was determined by considerations of net accelerating thrust. The geometry of the intake was chosen to yield the maximum installed net thrust with the minimum distortion of air flow at the compressor face, with inlet flow stability over the range of engine mass flows.

The angle of the intake external ramp is 12 deg., and the intake contraction and profile from the face of the intake lips to the throat was determined by one-sixth-scale models, tested to give the required total pressure recovery and acceptable distortion levels at low subsonic Mach numbers, without confliction with supersonic flow requirements.

A number of modifications were made to the ramps as a result of these tests. One of the problems encountered was an interaction between the inlet shock and the boundary layer from the ramp, which caused fluctuating conditions inside the intake similar to the commonly-known "intake buzz." Perforations were installed on the face of the ramp, and the boundary layer air from the ramp was sucked through these perforations by an extractor, seen below the intake, which has a series of cascades.

Gills immediately adjacent to the compressor inlet open up at M=0·5 and allow air to by-pass around the engine for cooling purposes, and to alleviate spillage at high Mach number. By this means, it is possible to achieve near optimum performance with this fixed geometry intake, in the subsonic, transonic and supersonic speed ranges. At very high Mach numbers, if the air which could not be swallowed by the engines was allowed to spill from the intake lips, there would be a high drag penalty, bad pressure recovery characteristics within the intake itself, and possible destabilising effects from the components of spillage.

The technique of by-passing air over the engine between the engine and compartment side walls not only takes care of the spillage, and cools the engine, but by acting as a heat exchanger, collects heat from the afterburner casing and passes it into the ejector exit annulus, providing a small percentage of additional thrust.

For fire protection, the critical compartments containing the fuel system, &c., are enclosed by titanium shrouds and stainless steel insulated blankets.†

The gills are automatic, and when the aircraft has reached a forward speed high enough to create a static pressure higher than ambient within the intake duct, the by-pass gills open, due to ram intake pressure, and allow the air to by-pass over the engine.

Stability.—The problem of obtaining adequate natural aerodynamic stability for an aircraft with the altitude and speed range of the CF-105 was extremely difficult, especially in view of the low-aspect ratio, and directional stability in particular was a problem.

With the very thin fin required with a supersonic aircraft there is a large reduction in fin effectiveness at high indicated air speed, and the fin lift falls off considerably, due to the lift slope curve decreasing with Mach number.

To achieve adequate directional stability over the complete flight envelope, we resorted to a synthetic "damping" system.

Longitudinal dynamic stability is satisfactory at low altitude, but deteriorates with altitude in the normal way, and above 40,000ft the natural damping required augmentation, to make the aircraft an effective weapon launching platform. The periods of oscillation are too short at high speeds for the pilot to be able adequately to control the response to a gust.

We were left then with a necessity to augment longitudinal dynamic stability at high altitudes for weapon launching, and to

† The "Iroquois" was illustrated on page 304, August 30, 1957.

augment lateral static and dynamic stability at a combination of high altitude and high speed to obtain adequate controllability. We did consider very carefully ways and means to produce better natural directional stability by, say, increasing the fin area some 50 to 60 per cent, or putting underslung dorsal fins, i.e. fins under the fuselage, but the performance penalties of doing this were considered to be unacceptable. For instance, if we increased the size of the fin, it would geometrically reduce the fin arm. It would also increase the fin weight and move the c.g. aft, which again reduces the directional stability, and so we would be getting into an area of diminishing returns.

It was therefore decided to obtain the required stability on all axes by artificial means, and since failure of the artificial damping system could be a problem in some areas of the flight envelope, it was also decided that the system must be made with either the same or better reliability than a standard power-operated system.

The highest possible degree of reliability and safety has been built in to the damping system. For instance, on the yaw axis, which is the most critical, there is complete duplication, including sensors, computers and hydraulic servos. The duplicate yaw axis system is called the "emergency damping system." The switchover from "normal" to "emergency" in case of a detected malfunction is automatic. The main sensing element is an accelerometer and, at low speed, a side-slip vane. It is therefore necessary for a double failure to occur before the pilot is left without damping.

Having given you our objectives, I might say that the damping system has proved to be quite a development problem, and much of our flight testing to date has been concerned with sorting out the system. However, we were quite aware at the outset that this would be the case and, on the other side of the ledger, the flight testing to date has shown that our directional stability is better than expected.

The system is designed to operate in conjunction with the automatic flight control system, which in turn is integrated with, and is an essential part of, the integrated interceptor electronic system. The main function of the damping system is to dampen the short period oscillations about all three axes, and to dampen the longitudinal long period oscillations.

The system provides turn co-ordination and side-slip minimisation in operational manœuvres up to 6 *g* positive in pull-outs, and 4 *g* positive in turns. This protects the fin structure from excessive loading. The damping system also provides for unco-ordinated manœuvres at the option of the pilot, which is carried out by a cut-off switch on the rudder bar, and provides a means of manual control.

The emergency damping system, which is on the yaw axis only, provides stability and damping of the Dutch Roll mode, and limits the side-slip to well within the structural integrity limit on the fin, in pull-outs or 2 *g* turn manœuvres.

SMOKE DENSITY TELESCOPE.—A smoke density telescope has been designed at the Fuel Research Station of the Department of Scientific and Industrial Research. It provides a simple means of assessing the density of plumes of smoke issuing from chimneys and is more convenient to use than Ringelmann charts. When viewed through the telescope the density of the smoke is compared with two translucent screens fitted on the body of the instrument and corresponding to No. 2 and No. 3 Ringelmann shades.

Hardwood Pulp Mill at Sudbrook

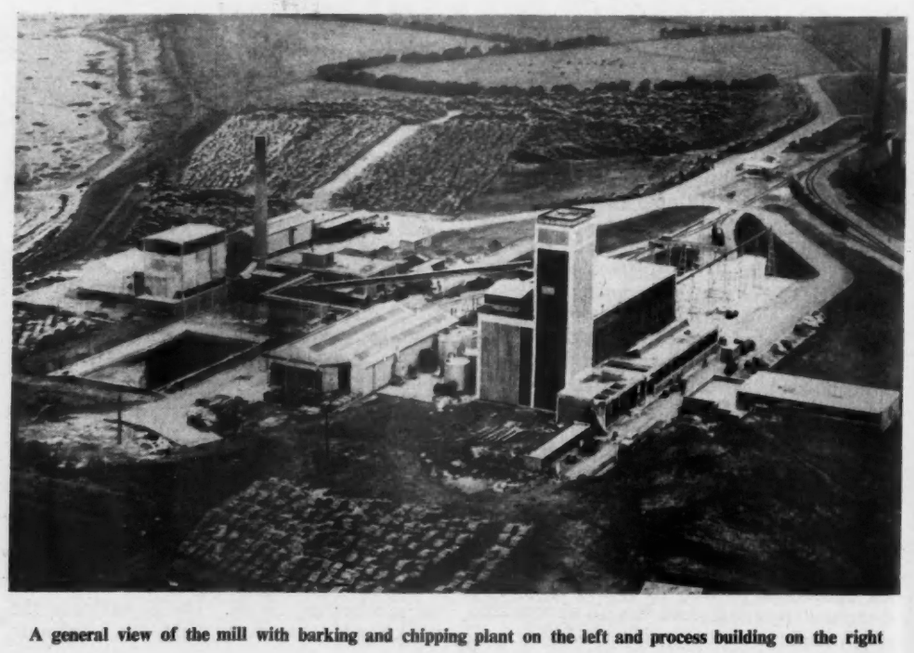
To improve the quality of existing papers and develop new ones, a bleached hardwood pulp was required and experiment showed that home-grown hardwood was suitable for this purpose. Three main factors governed the selection of a site for a mill to produce hardwood pulp and at Sudbrook these are satisfied since supplies of hardwood are available from the Forest of Dean and adequate quantities of water can be provided from the Severn Tunnel pumping station, while the tidal characteristics of the Severn provide the answer to the problem of effluent disposal.

INCREASED production of papers has expanded the demand for paper-making fibres and for a wider choice amongst them, while a study of future requirements has indicated that a characteristic liable to be increasingly required by printers and converters would be evenness coupled with regularity.

Attempts to develop a suitable range of papers by the Wiggins Teape Group revealed the need for a pulpwood, in particular a bleached hardwood pulp, which would blend with the raw materials currently available and give the desired characteristics to the papers in question. Research and technical advances in paper-making determined the type of pulpwood which would be suitable for blending with other fibres and further work indicated that home-grown hardwood when treated by a neutral sodium sulphite process would produce pulp to satisfy the specification. Having solved one problem, it was necessary to find the answer to two more, the first being the economic availability of raw materials and the second being the possibility of processing the pulpwood to produce wood pulp of the quality required. A sample of hardwood from the Forest of Dean was sent to America to compare qualities with American hardwood pulp and the results confirmed the findings of the Group's own laboratories so that it was decided to proceed with the project to build a hardwood pulp mill. Apart from technical development of the process, there was the question of a suitable site, the solution of which was governed by two main factors, namely, easy access to supplies of hardwood and adequate supplies of fresh water. Both these requirements were satisfied at Sudbrook, the site selected, which is near Chepstow and almost directly above the Welsh end of the Severn Tunnel.

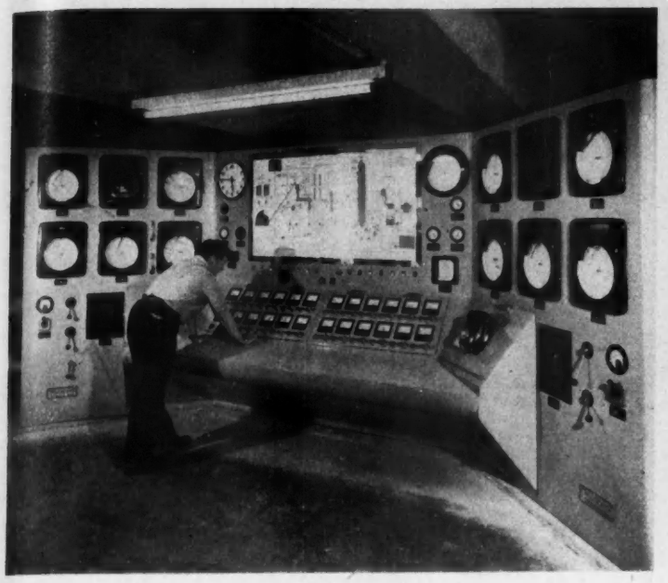
Deciduous (hardwood) trees which are grown in this country and are most suitable for the production of bleached hardwood pulp, are oak, ash, birch, beech, alder, elm, sweet chestnut, sycamore, lime, poplar, willow, hazel and maple. They are to be found in the Forest of Dean and their use in the production of the hardwood pulp, "Gatecel" has provided a ready market for the hardwood thinnings and a financial return to the Forestry Commission, while also being of some economic benefit to the country in that use is made of home supplies and no imports are required. The solution of the fresh water problem recalled the difficulties encountered in building the Severn Tunnel and the striking of the Great Spring, the waters of which have had to be pumped out at a rate varying from 14,000,000 to 34,000,000 gallons per day since the tunnel was opened in 1886. It is some of this clear, clean, hard water, which keeps a constant temperature of 50 deg. Fah., that is being used by the mill to convert hardwood into bleached wood pulp to the financial benefit of British Railways. The disposal of effluent, always a matter of considerable difficulty, has been solved by the abnormal character of the tides of the Severn Estuary. The effluent is stored in a reservoir and allowed to flow into the river when the tide is going out, so that it is carried away by the fast-running tide and being of small volume, compared with the tidal water, cannot be traced, it is claimed.

The mill has been brought into production recently and was officially opened on October 1 by Mr Peter Thorneycroft

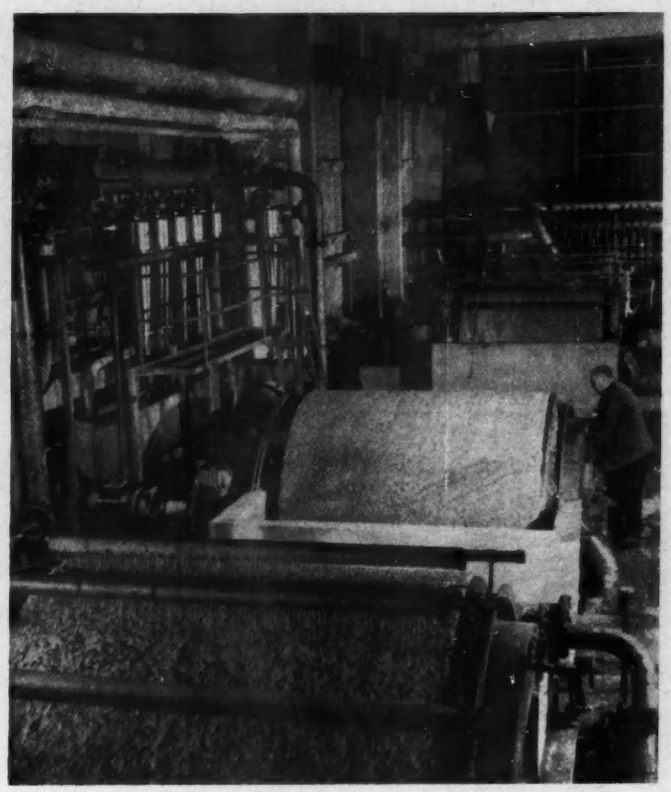


A general view of the mill with barking and chipping plant on the left and process building on the right

The Sudbrook Pulp Mill uses between 50,000 and 70,000 tons of hardwood per annum for the making of "Gatecel" and can be seen in our illustration, in which the barking chipping plant and chip silo are on the left, with digester tower and process building on the right. The pulpwood used is delivered by road or rail in 4ft lengths ranging in diameter from 3½in to 12in. It must be sound, reasonably straight and is purchased by weight, which is an incentive to suppliers to deliver immediately after felling, since freshly-felled wood contains sap and solids in equal amounts. The logs are transferred, by a crane using slings and a quick release beam, to a loading ramp where several inspections are made to prevent unsuitable and poor quality logs being forwarded by conveyors to the barking machines which are arranged in tandem and have self-opening triangular feed mechanism. Generally the pulpwood is forwarded to process as soon as it is received, but a stock is maintained in the wood yard to meet winter requirements. It is expected that a boiler burning bark as fuel will be installed shortly so that nothing will be wasted.



Process control instrument panel



Drum filters in the process building

After barking, the two streams of logs proceed by a single conveyor to a chute through which they drop into the chipping machine, in which a rotary flywheel, having ten knives mounted on one face, reduces a 4ft log to chips ¾in long in one section. The chips pass over a rotary chip screen which rejects the sawdust, returns oversize chips to the chipper and forwards chips of the correct size, 2,000,000 of which are required to make 1 ton of paper, to silos. There are three of these, each of 40,000 cubic feet capacity and holding about 300 tons, and at the base is a screw conveyor which travels along the length of the silos and transfers the chips to a belt conveyor for delivery to a hopper in the roof of the pulp mill.

From this hopper the chips are metered into steaming vessels, where they are heated and the air is removed. Afterwards they are mixed with hot liquors and pumped at high pressure to the top of the digester tower. In their passage downwards through the tower, which takes about four hours, the chips are treated with neutral sodium sulphite and the temperature reached at mid-point is about 350 deg. Fah. The action of the chemicals and heat removes the unwanted content of the pulpwood, such a lignin, leaving the cellulose and hemicellulose undamaged. Sodium sulphite, caustic soda, chlorine together with small quantities of soda ash and lime, are the chemicals mainly used. Our illustration shows the instrument panel which gives complete information as to the state of the process and by which one man maintains control.

The softened chips pass from the base of the digester tower through the blow tank to the refiners, where the fibres are mechanically separated in the presence of liquor to form a brown pulp. This is subsequently washed, cleaned and bleached, the washing being done on five drum filters, while sand and shive is removed in cyclones which can be seen on the left of our illustration of the drum filters. Bleaching is carried out in three stages, chlorine gas being injected at the base of the first stage tower through which the pulp takes one-and-a-half hours to pass. Before entering the second tower, which has a time cycle of thirty minutes, caustic soda solution is added to the pulp and then, after the addition of calcium hypochlorite solution, the pulp takes five-and-a-half hours to travel through the third tower. After each stage the pulp, which is circulated by pumps, is washed on drum filters. The fully cleaned and bleached pulp is formed into an endless sheet which is slit lengthwise into four strips and then, after turning, cut across. These sheets are piled to form bales, having a wet weight of 450 lb, which are automatically lowered to a conveyor for transfer to a hydraulic press, where the height is reduced to about 18in, ready for wiring. The bales are moved by fork lift truck to storage, ready for delivery to the paper mills of the Group.

The consulting engineers were W. S. Atkins and Partners and the contractors the Turriff Construction Corporation, Ltd.

The main machinery suppliers were: Karlstad Mekaniska Werkstad (chipper digester); Soderhamms Verkstader A.B. (chip screen and barking machines); Sprout, Waldron and Co., Inc. (refiners); Black-Clawson International, Ltd. (stock pumps); South Wales Switchgear, Ltd. (transformers and switchgear); Johnson and Phillips, Ltd. (low tension panel); James Hodgkinson (Salford), Ltd. (conveyors); Herbert Morris, Ltd. (cranes).

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

GEAR HOBBING MACHINES FOR SMALL PRECISION GEARS

No. 3013 : 1958. Price 6s. This publication relates mainly to fine pitch precision gears such as are used in instruments where the smallest possible errors in angular motion are an essential requirement. It is intended to establish standards of accuracy for gear hobbing machines for the production of precision gears in a range up to 3ft diameter.

The requirements for accuracy limits on gears for machine components include those for hob saddle motion, hob spindle and hob arbor, main indexing worm and worm assembly, master wheels and table motion. A section of the publication dealing with inspection and testing includes accuracy limits for test blanks and test gears after cutting. A chart showing permissible transverse pitch errors is included.

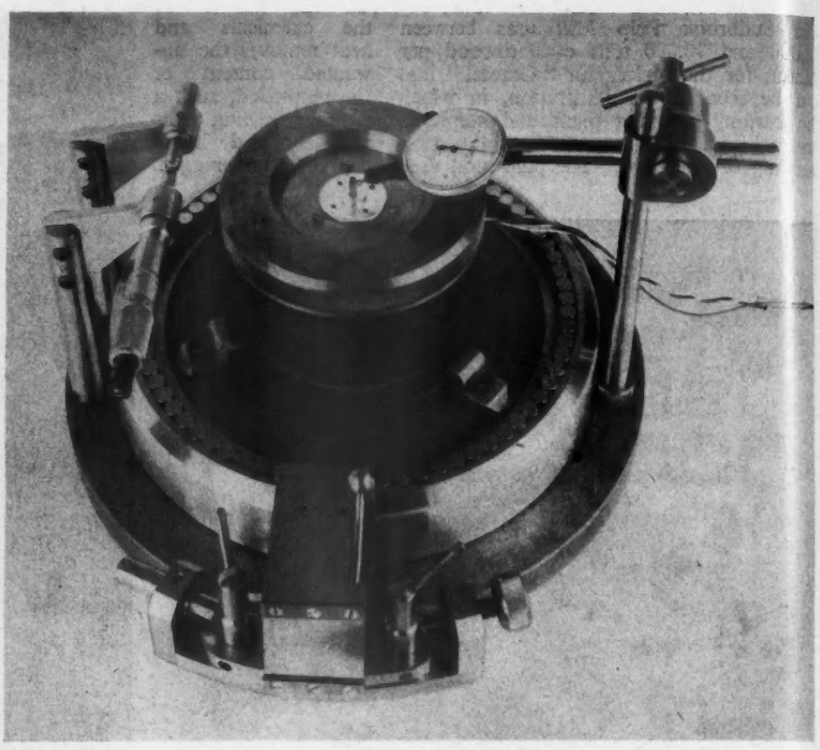
RAMSHORN HOOKS

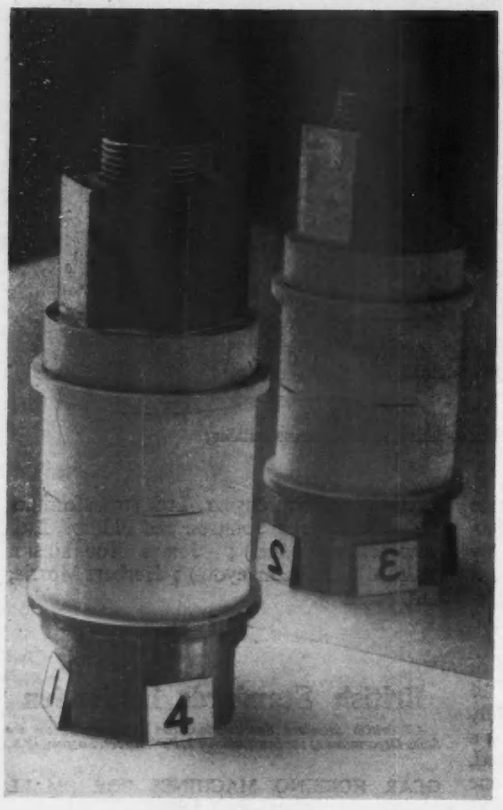
No. 3017 : 1958. Price 5s. The mild steel forged ramshorn hooks specified in this new publication have a range of safe working loads of from 20–200 tons, and they are recommended for loads beyond the range of hooks to B.S. 482 and B.S. 2903. The standard specifies requirements for material, form, dimensions, workmanship, heat treatment, testing, marking and certification. Form and dimensions are illustrated by a figure and an associated table. For light loads, shackles may be fitted centrally to the hooks.

An appendix titled "Notes on design" provides for the design of hooks which are above, below and between the listed sizes. The standard lays down, however, that the use of the term "British Standard Ramshorn hook" is restricted to descriptions of hooks having the sizes and forms specified in the tables. Another appendix provides assistance in the selection of suitable thrust bearings; and the publication concludes with a series of recommendations on the use of ramshorn hooks.

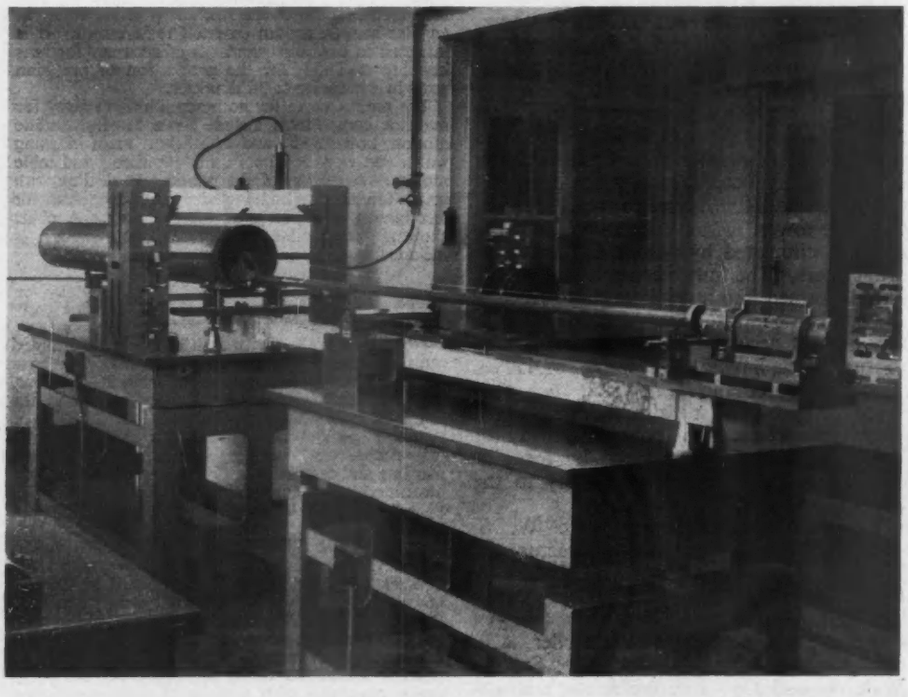
Inspection Techniques

Last week open days were held at the Harefield laboratories of the Aeronautical Inspection Directorate, and some of the techniques of the A.I.D., the Inspectorate of Electrical and Mechanical Equipment, and the Chemical Inspectorate, were displayed. These included radiography for the inspection of completely skinned aircraft components, and a method of detecting the vibration of components mounted within a closed box by vibrating the assembly by a strain-gauged link and measuring the force needed to excite it, a critical frequency for some component lying between a maximum and a minimum on a base of frequency.





Illustrated ABOVE is a highly accurate dividing head for use in the testing of angular transducers or synchros. Intervals of 5 deg. are established by a ring of seventy-two selected parallel rollers: we are advised that on the first attempt the rollers occupied the specially made housing exactly, no fitting being required. A radius arm can be attached to the synchro spindle and driven by the micrometer mounted on the base, when a displacement of 0·001in will be one minute of arc.
On the LEFT is seen a " demountable artificial defect," developed for use in the testing of penetrant flaw detection fluid. The assembly can be built up to provide a series of flaws of known sizes and then be dismantled and cleansed of the test materials. It consists of two steel collars, the adjoining faces of which have been lapped together, one of which has been recessed at four areas adjoining the outer edge to depths of 0·001in, 0·002in, 0·003in and 0·004in. The collars are clamped together, with a torque of 200 lb-ft, with a soft metal foil between them and the surplus metal trimmed off : the " defect " then appears as seen here. These flaws are found to give reproducible results for any given detecting fluid.



An apparatus for checking the wall thickness of a long tube is shown LEFT. A channel-section beam carries an anvil at one end and an alignment telescope at the other. A long, small-bore tube is mounted opposite the telescope and pivoted to allow it to rise and fall : the far end of the tube carries a stylus, which is immediately above the anvil, and a target for the telescope optical system. This tube enters the tube to be measured, and the wall thickness imposes a clearance between stylus and anvil : the device can be calibrated by inserting slip gauges between anvil and stylus.

SHORTER REPORTS

Report of the Gas Council

THE ninth annual report and statement of accounts of the Gas Council and those of the twelve area gas boards in this country were published early this week. The report of the council for the year, which ended March 31, 1958, showed that the gas industry had a gross income of £388,600,000 on which it had a net surplus of £2,820,600. It is of interest to note that since the vesting date (May 1, 1949), the industry has invested £422 million in fixed assets. During the year under review the capital expenditure totalled £55,700,000 of which £22,700,000 was spent on manufacturing plant and £14,500,000 on mains. New gas-making plant with a capacity of 124 million cubic feet a day was brought into use and plant of 136 million cubic feet a day capacity was scrapped.

In continuance of the industry's scheme to concentrate gas production in large and economic works a further seventy-five small works were closed during the year, leaving only 536 gas manufacturing works in this country, as compared with 1050 at vesting date, although productive capacity has increased by 23 per cent. The total capacity of gas manufacturing plant at the end of the year under review was 2,528 million cubic feet, or 12,000,000 therms, a day.

In connection with gas supply it is shown that of the total gas available 82·7 per cent was manufactured, 16·6 per cent came from coke ovens and 0·7 per cent from oil refineries. Of the gas manufactured 67·9 per cent was coal gas (using over 26,000,000 tons of coal), 13·5 per cent water gas and 1·5 per cent from other processes. The amount of carburetted water gas made was considerably increased in order to reduce abnormally large stocks of coke. Eleven new oil gasification plants were placed in commission during the year, bringing the total number in service to twenty-five, whilst fourteen other plants were under construction or on order. Reference is made to the experiment being carried out out on the council's behalf by the North Thames Area Board, in connection with the importing of a trial cargo of liquefied methane. It is hoped that if this experiment proves successful approval will be given for the importation of liquefied natural gas in bulk, as a cheap means of producing and supplying gas.

The report states that the outstanding feature of the year under review was the progress which had been made in the practical development of new processes and sources for the supply of gas. Notes are given on the research programme directed to processes which can make use of the poorer quality coals or alternative raw materials, as well as methods of improving the efficiency of carbonising plant. Although particulars of some of the projects have been given in our columns from time to time they are worth being recalled briefly.

Research carried out at the Midlands Research Station has led to the construction of a full-scale plant for further experiments in the manufacture of gas by the hydrogenation of coal or oil at high pressure now in hand at the Partington works of the North Western Gas Board, near Manchester. Another development of this research is the construction by the South Western Gas Board of plant for the hydrogenation of light petroleum distillates at Bristol. The Scottish Gas Board is building a works for the complete gasification of poor quality coal at high pressure at Westfield, Fife. As the first stage of the largest project for the gasification of oil, a new works is being constructed by the South Eastern Gas Board, adjacent to the Isle of Grain oil refinery.

A regular supply of surplus gas is already being taken by the Southern Gas Board from the Fawley oil refinery, and the North Thames Board has entered into agreements for supplies of gas from the Shell Haven and Coryton refineries. It is stated that when these three supplies are in full operation they will be equivalent to the gas produced from 500,000 tons of coal.

In connection with the use of methane gas from the coal mines it is shown in the report that the Wales Area Board has increased the amount of methane taken from coal mines, whilst the West Midlands Board has begun to take a supply from the mines in North Staffordshire and the Scottish Board is to receive a supply from Scottish pits. The economics of a national gas grid in relation to new methods of production are being studied. This scheme envisages the siting of large production units near coalfields and refineries and feeding gas at high pressure into the grid, which could also be fed with gas from other sources.

Canadian Structural Testing Installation

STRUCTURAL designers have recently become more conscious of the interaction that exists between the various components which make up a building or other structure. To investigate this interaction of components it is frequently desirable to test full-scale structures or assemblages of components. The building structures section of the Canadian building research organisation recently acquired a test rig for conducting these full-scale tests. Before the rig was available it was necessary to design and construct *ad hoc* apparatus for tests on houses, roofs, beams, floors, walls and slabs. It was often difficult to develop the large forces and reactions necessary to determine the failure load, and in general, it was found that ordinary universal testing machines were very limited in their application to such testing particularly because they were not sufficiently adaptable.

Before deciding on a large-scale structural testing installation for the Building Research Centre in Ottawa, several installations in North America and Europe were visited or studied. It was found that although they varied considerably in detail the common basic parts were first, a reinforced concrete anchorage base, second, structural steel sections which could be assembled and bolted together in any desired manner around the test object and anchored to the base, and third, a number of portable hydraulic jacks for the application of the loads. One of the most modern of such testing installations was considered to be that at Lehigh University in Bethlehem, Pa. This installation uses high-strength bolts for the rigid assembly of the reaction frames and pretensioned bolts for anchoring the frames to the slab. This feature is considered particularly important in case of dynamic testing as it eliminates slack in the reaction framework.

The installation at Ottawa consists of a heavily reinforced anchorage slab approximately 3ft thick resting on bedrock and anchored to the rock by pretensioned anchor rods. The slab is T-shaped in plan, with a long part (54ft by 8ft) for testing long members such as beams, and a roughly square part (23ft by 28ft) for testing slabs, roofs, &c. The anchorage points are spaced approximately 4ft apart in the slab which has been designed to withstand vertical or horizontal forces up to 50 tons at each point. Particular care was taken to achieve accuracy in the vertical and horizontal location of the anchorage points so that all parts of the reaction system would be completely interchangeable. The accuracy achieved was approximately $\pm\frac{1}{16}$in. There are forty-two anchorage points each consisting of a pair of threaded sleeves and 2in bolts recessed into the floor. The rock anchors, of which there are twenty-six, consist of 2½in diameter high-strength steel rods and reach about 10ft below the slab. After the slab was completed, each anchor was pretensioned with a force of approximately 70 tons.

At present, the reaction frames for the test installation consist of six 12in wide-flange columns, three cross beams (pairs of 18in channels) and two spreader beams (12in wide-flange sections). The columns are attached to the slab by pairs of 2in pretensioned high-strength bolts. The connection of the spreader beams to the cross beams is through two yokes, allowing positioning at any desired point in one direction while the jacks themselves can be shifted along the spreader beam in the other direction. This makes it possible to apply a force at any position on the structure under test.

The hydraulic system consists of a set of Amsler portable compression jacks ranging in capacities from 2½ tons to 50 tons. These jacks are lapped piston devices used with a pendulum dynamometer, so no separate load measuring devices are needed. Each jack contains a spherical seat at the base and where the load is applied. The jacks can be connected to the pendulum dynamometer in groups to obtain identical loads at a number of points to simulate uniformly distributed loads on structures. The jacks can also be used in conjunction with a pulsator for the application of fatigue loadings to structures. As yet, pulsators are not part of this installation. This installation is the first of its kind in Canada and represents the major structural testing facility of the Canadian Division of Building Research.

E.R.A. and the Commonwealth

ALTHOUGH the work of the Electrical Research Association (E.R.A.) has long been well known in Great Britain, its activities are less familiar overseas. Accordingly, an overseas liaison unit has recently been established by the E.R.A., under the responsibility of Mr. E. W. Golding, O.B.E., who is also head of the Association's rural electrification and wind power department. The main aim of this new section will be to maintain close contact with electrical engineering activities overseas, to improve the service given to E.R.A. members in the Commonwealth and to ensure that full advantage is taken of the services which the Association can offer and that its researches shall cover the widest possible range of interest.

The work of the Association includes research programmes on a large number of subjects which are of interest to its members—electricity supply authorities, engineering manufacturers and users of electrical energy. In addition to the research facilities provided in its own laboratories and field stations, the E.R.A. has the advantage of being able to undertake co-operative researches in collaboration with its members and with other research organisations interested in related subjects. Many of the problems facing electrical engineers in Commonwealth countries are almost identical with those met in Britain, but there are others, peculiar to different areas, climates and economic conditions, which call for special consideration. It is believed, however, that such problems could be solved by the E.R.A., either through some modification of existing researches to include these new aspects or, perhaps, by initiation of new programmes framed to meet overseas requirements. The first step towards the solution of any problem must be to gain a clear understanding of the exact nature of the question to be answered. As one attempt to overcome the handicap of long distances which preclude verbal discussions except on a few random occasions, an overseas newsletter has been initiated. The first issue of *The E.R.A. Overseas Newsletter* has just been prepared and its successors will be sent out at six-monthly intervals. Its purposes are to outline the research work of the E.R.A., with special emphasis on programmes which may interest Commonwealth members; to give brief notes on past and forthcoming electrical engineering meetings, conferences and other similar activities in Great Britain; to call attention to recent developments by British electrical engineering

manufacturers, and to new books and relevant articles in the Technical Press ; and to provide a medium for the exchange of views and experiences between the Commonwealth members in different parts of the world.

That there are common problems which could be solved by co-operative efforts is almost certain; the present object of the E.R.A. is to take the initiative in bringing these problems to light. Inquiries should be addressed to Mr. E. W. Golding, O.B.E., Overseas Liaison Officer, The Electrical Research Association, Savoy Place, London, W.C.2.

Hydraulically-Operated Grab for Mobile Crane

A HYDRAULICALLY-OPERATED grab has been developed by K. and L. Steelfounders and Engineers, Ltd., Letchworth, for use on the standard design of Jones " KL33 " and " KL66 " mobile cranes in order to adapt them for the economic and speedy handling of coal and coke in distributors' stock yards. The grabs for the " KL33 " are of 1 cubic yard capacity and those for the " KL66 " of 1½ cubic yard capacity. A " KL66 " machine with the new attachment can be seen in operation in the photograph we reproduce.

On the cranes the hydraulic grab is fitted directly to the head of a cranked jib through a universal pivot mounting. With this form of jib head mounting the grab can be lowered gently into contact with the coal or coke by derricking the jib, its weight being taken at all times by the crane and not by the material on the stock pile. The method of operation is such that the impact which tends to break large coals when using the normal design of rope-operated grab, which depends upon its weight for effective pick-up, is eliminated. During the closing operation the grab is held in contact with the material and during discharging coal can be laid directly or, if required, dropped from a height on a stock pile. The rate of discharge is at all stages under the complete control of the operator, who can quickly open or close or hold the bucket jaws at any required spacing. It will be appreciated that the full circle slewing design of these cranes enables them to be located between a stockpile and a vehicle to carry out grabbing duties by slewing and derricking only. They can also be supplied with four-wheel steering to facilitate manœuvring in restricted areas.

The cantilever jibs of the cranes are made in two sections connected by a link which provides a cranked pin which enables a grab to be lowered to ground level. This link can easily be removed and the jib sections lined up if it is required to convert a machine for normal crane duties. Power for operating the double-acting hydraulic ram of the grab is taken from the main hydraulic circuit of the standard derricking gear of a crane.

In the course of a recent demonstration of the new grabs in the coal stockyards at Cambridge of Austin Beales and Co., Ltd., we saw the speed and ease with which coals and coke of various sizes could be handled with the equipment. A " KL66 " with a 1½ cubic yard grab completed eight cycles in three minutes in loading 3 tons 8 cwt of 2½in by 4in coal cobbles from a railway truck into a lorry. A " KL33 " with its 1 cubic yard grab in the same time completed four cycles and loaded 1 ton 17 cwt. Subsequent demonstrations showed the effective use of the " KL33 " in handling material to the maximum discharge height of 11ft 3in and at 13ft 3in radius. The larger machine has a maximum discharge height of 18ft and a 19ft 3in working radius.

Automatic Boiler Control in a Leicester Factory

A MARKED improvement in combustion efficiency is claimed for a new automatic electrical control system designed by Kelvin and Hughes (Industrial), Ltd., Notts Green, London, E.10. At a trial installation in the British United Shoe Machinery's factory in Leicester, an increase of 7½ per cent in boiler efficiency has been achieved over manual firing under identical conditions. The system was first installed during the summer of 1957 and was incorporated gradually into the plant to avoid any interruption of steam supply. The plant first went into operation on fully automatic control, connected to two boilers for comparison with manual firing and for testing certain boiler components. As a result of this trial, the system has since been extended, with the complete modernisation of the plant to control four Cochrane " Economic " boilers.

In the Leicester factory superheat coils supply steam at 450 lb per square inch to a back pressure turbine, connected to an electric generating set which supplies part of the factory load ; the boilers also supply steam at 140 lb per square inch for process work and factory heating. Each boiler is fitted with two Hodgkinson low ram, reciprocating bar stokers, driven by a constant-speed a.c. motor, the coal feed to each grate being capable of manual adjustment. The automatic control instrumentation is contained in an illuminated panel about 20ft from the front of the boilers.

A master steam pressure controller is connected to the common steam header and sends pulsed signals to individual combustion controllers which regulate the coal feed and air flow to each boiler. To regulate the coal feed, the signal pulses are relayed to a constant-speed motor for cyclic operation which is predetermined in this case at ninety seconds, the running time being proportional to the load signalled by the master controller. Airflow is controlled by a damper, operated by a push rod from a reversible a.c. motor through reduction gearing. A measurement is taken of the pressure differential across the boiler passes, which produces an operating force on a diaphragm unit, the output of which is in opposition to a control spring, tensioned by a square-law cam which moves in response to the load signals. The resultant balance between the diaphragm and control spring positions a switch which controls a Nelson geared damper motor rated at 250 lb-in torque at 1 r.p.m. The airflow is thus controlled by a closed loop.

Switches are provided on the combustion controllers to enable the operator to select manual control and to increase or decrease the heat regulation at will. The controllers are balanced to permit load-sharing between the boilers and, once set, require no further rebalancing unless the load sharing is to be varied.

One advantage of this kind of control system is its versatility and adaptability to any type of boiler or firing appliance. The output from the combustion controller to vary the fuel rate can easily be adapted to a d.c. stoker motor and a feed-back from the armature voltage of the motor can be included.

With oil firing, the master controller is used to operate the oil and air control simultaneously. Pulses are received by a servo heat motor which positions the oil valve and air louvres, or air damper, through linkages which compensate for valve and damper characteristics.

Statistics compiled at the end of a two-month continuous operation period draw an interesting comparison between the efficiency and resultant economics of automatic as opposed to manual firing. The coal used is of a variety known as " Desford Beans " the calorific value of which is 10,117 B.Th.U. per pound.

Automatic Control

	Steam produced	Coal burned
December 1957	17,435,800 lb	2,502,080 lb
January, 1958	16,934,140 lb	2,435,776 lb
Total...	34,369,940 lb	4,937,856 lb

Steam per pound of coal	6·95 lb
Boiler operating pressure	140 lb per sq. in.
Superheat temperature	450 deg. Fah.
Temperature of water inlet to economiser	135 deg. Fah.

Therefore, calculated from steam tables, the total heat produced over this period was 1145 B.Th.U. per pound steam, or 9757 B.Th.U. per pound of coal. Taking a calorific value of 10,117 B.Th.U. per pound this makes an overall efficiency of 78·5 per cent compared with a possible 82 per cent claimed for the boilers by the manufacturers.

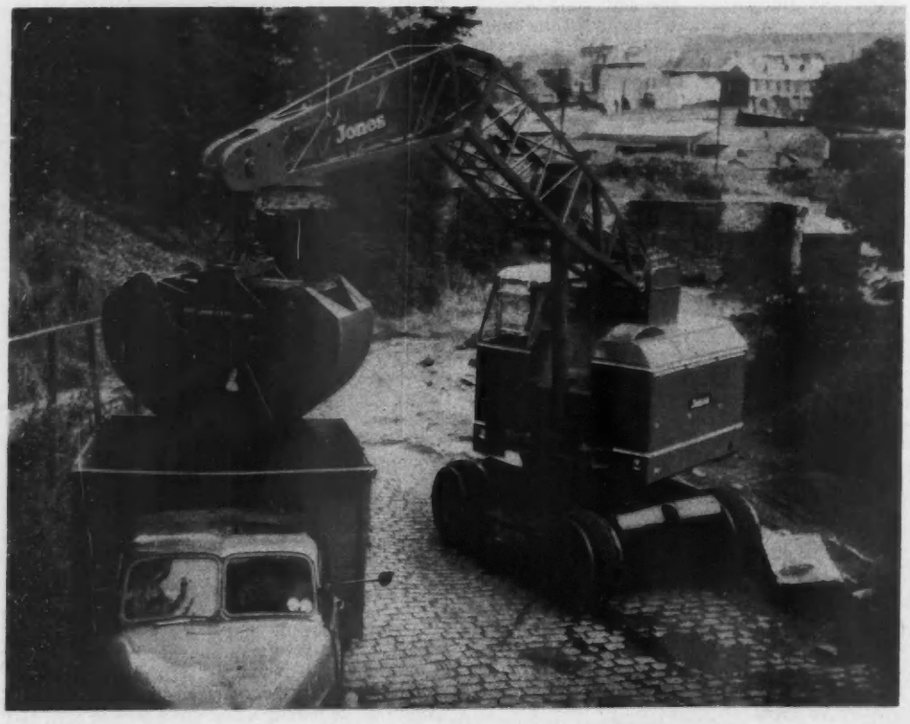
For a three-month period under similar conditions, the corresponding figures for manual operation were as follows.

Manual Control

	Steam produced	Coal burned
January 1957	10,462,300 lb	761 tons 18 cwt
February 1957	10,993,200 lb	800 tons 8 cwt
March 1957	10,354,900 lb	754 tons 2 cwt
Total	31,810,400 lb	2316 tons 8 cwt
Steam per pound of coal	6·3 lb	

The overall efficiency was, therefore, 70·9 per cent, a decrease of 7·6 per cent below the automatic control figure.

The annual production of steam at the plant is 120×10^6 lb. Taking the values of steam per pound of coal, 6·95 lb on automatic control and 6·3 lb on manual control, as obtained above, the annual coal consumption is 7700 tons on automatic control and 8500 tons on manual control. Assuming coal costs of 72s. per ton the saving shown by automatic control is £2880 per annum. Accordingly the cost of installation will have been met by economies from six months' operation.



Mobile crane, fitted with 1½ cubic yard hydraulically-operated grab, handling coal

Industrial and Labour Notes

Balance of Payments

According to a Treasury White Paper (Cmd. 540) published this week, the present estimate for the current balance of payments in the first half of this year shows a surplus of £334 million, compared with the revised estimate of £154 million for the latter half of 1957 and £118 million for the first half of 1957. The improvement of £216 million between the first half of 1957 and the corresponding period of this year is the net result of a number of substantial changes in individual items.

The major favourable factors were falls in payments for imports and in shipping debits and an increase, largely ascribable to the net earnings of the oil industry, of £68,000,000 in receipts from "other invisibles net." On the other hand, export and re-export receipts fell and shipping credits and Government credits declined. The balance of visible trade improved still further in the first half of this year when there was a surplus of £137,000,000 in place of the usual deficit. But this improvement, the White Paper explains, was due to reduced import prices. There are no estimates of volumes of imports and exports as recorded in the balance of payments, but volume figures based on the trade and navigation accounts show that, compared with the first half of 1957, imports were little changed while exports fell slightly.

Steel Production and Consumption

British steel production in September showed some recovery from the effect of annual holidays. It averaged 368,600 tons a week and was thus at an annual rate of 19,169,000 tons, compared with a rate of 22,789,000 tons in September last year. Pig iron production in September averaged 230,900 tons a week, compared with 282,700 tons a year earlier. Throughout this year, iron and steel production has been declining; a quarterly comparison of 1958 with 1957 shows that in the first quarter of 1958, steel output was 1 per cent down on 1957, in the second quarter it was 10 per cent lower and in the third quarter, 16 per cent.

In presenting these figures, the Iron and Steel Board says that, in recent months, the main decline in steel deliveries has been to the export trade and in the home trade to the collieries, to makers of railway rolling stock, to shipbuilders and, with the exception of ferro-concrete bars, to structural engineers and the building industry. In part, the Board maintains, the reduction in deliveries has been due to the running down of stocks by both public and private consumers. The Board goes on to say that steel deliveries to consumer goods industries have kept up quite well and that exports of engineering products and other metal goods, which in the second quarter of this year were in terms of steel content 10 per cent below those in the comparable quarter of 1957, now show a rather more favourable comparison with last year's figures.

As to raw materials, the Board's comment is that, comparing the first nine months of this year with the corresponding period of 1957, the decline in steel production was 8·8 per cent and the decline in consumption of steel-making materials was 8·6 per cent. So far this year there has been little change in the consumption of internal scrap arisings, the principal decline having been in imported scrap, imported pig iron, home bought scrap and home produced pig iron in that order. In the first nine months of this year, pig iron production was 8·6 per cent lower than in the corresponding period of 1957. Consumption of home ore declined by 15·2 per cent as against 9·2 per cent for imported ore, while consumption of scrap at the blast-furnaces increased by 16·6 per cent. The greater fall in home ore consumption was partly due to the higher use of scrap in Midlands blast-furnaces based on home ore and to the lower demand for pig iron resulting from the closing down in South Wales of cold metal steel plants which had been obtaining their supplies from the Midlands blast-furnaces.

Dollar Exports

The Dollar Exports Council is to hold a conference of industrialists and exporters at Eastbourne, on December 3, 4 and 5. The object of the conference is to discuss fully the whole question of future exports to the dollar markets. Sir William Rootes, the chairman of the Council, emphasised at a Press conference on Monday that the dollar markets included not only the U.S.A. and Canada, but also the fourteen Latin America dollar account countries and certain areas of the Pacific as, for example, the Philippines. The forthcoming conference, Sir William said, would be more than a "talking shop." It would be "a kind of foundry where ideas would be thrown into the melting pot and recast in the heat of criticism and the light of experience."

Sir William went on to say that, since the last conference of the kind was held seven and a half years ago, this country's exports to the U.S.A. had increased in value by 87 per cent, those to Canada by 49 per cent, and those to the dollar markets of Latin America by 58 per cent. In the comparatively new markets of the Pacific Islands, he added, United Kingdom exports were running at the high figure of 31,000,000 dollars a year, an increase of 33⅓ per cent over 1956; this country's exports to the Philippines alone were now 25,000,000 dollars a year. But, Sir William pointed out, there was still an adverse balance of trade with the dollar markets and there was great scope for further expansion.

The opening address at the conference on December 3 is to be given by the President of the Board of Trade, Sir David Eccles. At the conference dinner, on Friday, December 5, the principal guest will be the Prime Minister, the Right Hon. Harold Macmillan.

Employee Benefits

A booklet entitled "The £ s. d. of Welfare in Industry" has been published recently by the Industrial Welfare Society. It has been prepared by Mr. William Durham and presents the results of an investigation into the cost of personnel administration and employee benefits. There were fifty-five companies, all members of the Industrial Welfare Society, which supplied much of the information on which the booklet is based. Of the firms which collaborated, twenty-one are in the engineering industry.

The booklet points out that the time has long since passed when the employee received only wages in return for his labour. Social security measures paid for partly by the employer were introduced in 1905 and holidays with pay became common between 1919 and 1939. To-day, supplementary sick pay and pension schemes for all employees are being increasingly introduced by industrial firms; canteen subsidies are normal, and sports and social clubs, employee magazines and medical services are further costs related closely to the numbers employed. These benefits, the booklet states, together form an additional cost of between 12 and 25 per cent of the total employee remuneration. In the survey, which was made, the median figure is £84 per employee per year. When the engineering companies which provided information are considered separately, the conclusion is reached that the amount spent by them on employee amenities is equivalent to an addition of 12 per cent to the annual wages bill.

One of the reasons advanced in support of a survey like that which has now been produced is that the costs of these benefits are not always apparent to, or appreciated by, employees. Few workers, the booklet says, realise how expensive a really good pension scheme can be. It is possibly true that the various employee benefits are of no great help in attracting labour, for in that matter the level of wages is probably critical. But in retaining labour, the fringe benefits, the human relations policy, the atmosphere within the firm and the wages are all of real importance. To date, the author of the booklet asserts, the trade unions have shown no great interest in these benefits, except for holidays. But, he comments, "it cannot be expected that this will always be the case and those firms which at the moment provide the barest minimum may be interested to know how far they are behind the average."

Coal Outlook

In a speech at Nottingham on Wednesday of last week, the deputy chairman of the National Coal Board, Mr. J. Latham, claimed that it would be a mistake for the Board to turn its long-term plans upside down because of the present weakness of the markets. The Coal Board, Mr. Latham said, was not being unrealistic in this matter; it did take quite seriously the competition of oil and later of nuclear energy as well as the effect on the coal industry of the slackening of general industrial activity. The Board was satisfied that it should budget for recovery, Mr. Latham continued, as it was impossible to assume, for example, that the iron and steel industry would remain in its present state over a long period of years. Nobody could be precise about the tonnage of coal needed in 1965 and 1970, but despite recent experience, no responsible person was in any doubt that, sooner or later, more coal would be needed than was being produced to-day. The Board's great problem in recent months had been to adapt itself quickly to rapidly changing circumstances in an industry which was inflexible by its very nature.

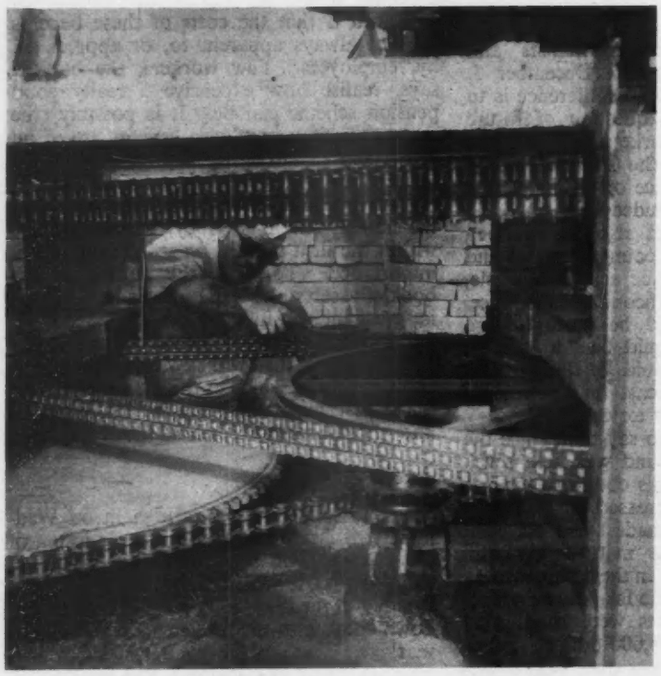
Mr. Latham also referred in his speech to the suggestions which had been made that the heavy coal stocks which existed should be offered at "knock-out prices." The test, he said, was a simple one, namely, would sales at substantially reduced prices increase the total demand for British coal or would such action merely substitute sales at reduced prices for sales which would have taken place in any event at more remunerative prices? The coal stocks, he urged, represented a valuable asset; indeed, it was desirable that the coal industry should build up some stocks when industrial activity slackened so as to meet the first impact of increased demand for coal when industrial activity improved.

Electricity from Bullocks

BY OUR INDIAN CORRESPONDENT

PRODUCTION of electricity by bullock power was recently demonstrated at an experiment conducted in a small village outside New Delhi by Mr. Leigh Stevens, an American management consultant, who, with the assistance of U.S. industrial firms and the Ford Foundation, has been working on this project over the last few years. Mr. Stevens was a member of an international study team on small industries sponsored by the Ford Foundation which, during its visit to India in 1953, arrived at the conclusion that shortage of water for household and irrigation purposes, and electricity for powering small village industries were the main problems facing village people in India. Mr. Stevens has now returned to India to demonstrate that it is possible to obtain power for both pumping and industries from local resources such as the village cattle.

The pump unit which was designed by the Tennessee Gas Transmission Company of Houston, Texas, is in three parts : the pump itself, a vertical drive shaft and the driving mechanism. The pump is a positive displacement rotary pump with a lift capacity of 300 gallons per minute. The driving mechanism consists of two draw bars turned by bullocks walking in a circle and thereby revolving a series of chains and sprockets. There are two stages of sprockets, —the first set converting 2 r.p.m. bullock speed to 20 r.p.m., and the second converting the 20 r.p.m. to 150 r.p.m., the desired speed for turning the pump. For the electric generator, a third further increase is achieved by belts in the same driving mechanism, converting the 150 r.p.m. to 1320 r.p.m.—the speed of the generator. In the present experiment, the pump mechanism can be drawn by a minimum of two to a maximum of eight bullocks. Tests are still in progress on the optimum number of bullocks required.

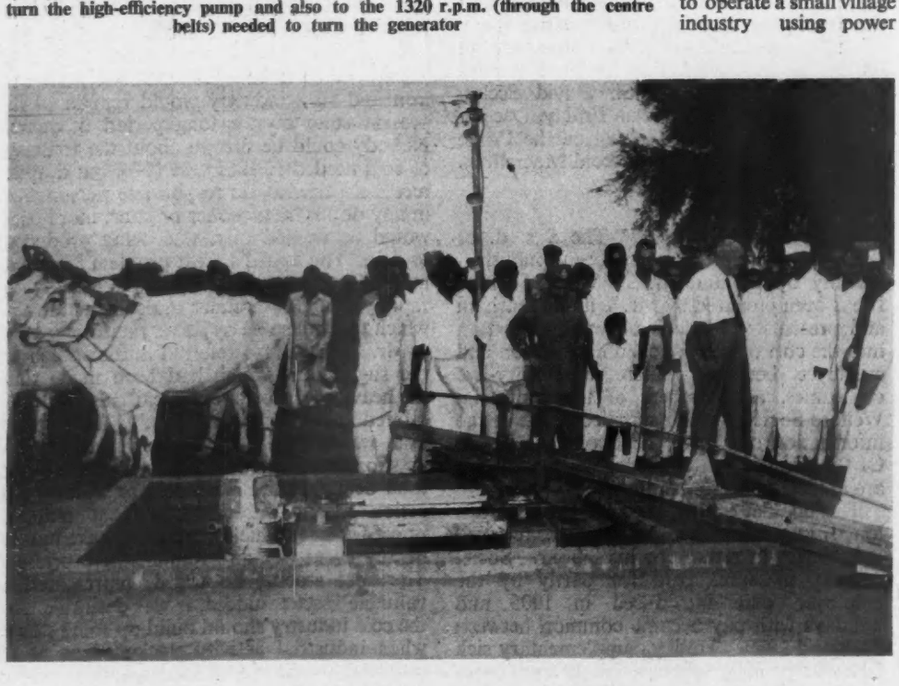


The driving mechanism consists of a system of chains and sprockets to convert the bullock speed, approximately 2 r.p.m. (through the upper double chain), to the 150 revolutions (through the single lower chain) needed to turn the high-efficiency pump and also to the 1320 r.p.m. (through the centre belts) needed to turn the generator

The generator, designed by General Electric Company (U.S.), is turned by bullocks pulling the same draw bars as for the pump. The pump is simply switched off and the generator switched on, as necessary. The generator has a capacity of 4·5kW, 125V, d.c., running at 1320 r.p.m. It produces sufficient power by day, to operate a small village industry using power equipment and employing twenty to fifty workers. For demonstration purposes, a power-driven wood-working shop has been erected at Khanpur to be run by the bullock-driven generator ; by night, to light 150 houses with one 25W bulb in each house, and fifteen 100W street lamps.

Since power is generated only when the generator is running, storage batteries are to be installed for balancing out the load. The electric switchboard, of a special type, was designed by the Smith Meeker Corporation of New York.

The cost of the combination pump and generator unit with its driving mechanism has been estimated at Rs. 25,000 (about £1875) if and when manufactured in India, and possibly as low as Rs. 15,000 if mass produced. There are over 550,000 villages in India, of which only about 20,000 have been electrified so far. The cost of electrifying an Indian village by conventional means (that is, from the national grids) is estimated to be of the order of Rs. 60,000 per village (£4500), excluding the cost of generating equipment. Mr. Stevens's experiment would thus appear to have possibilities of revolutionary significance. The combined power potential of the bullock population in India is probably greater than the installed capacity of public utility undertakings in the U.S. (124 million kW). It may be mentioned here that the corresponding figure for India is less than 3,500,000kW.



Bullock-driven pump-cum-generator in action

Heavy Electrical Plant in India

A FORMAL agreement between the Government of India and the Associated Electrical Industries was signed in New Delhi last month whereby deferred payments have been arranged to cover the entire foreign exchange cost of the first phase of the Heavy Electrical Project at Bhopal, estimated at Rs. 5 crores, for the purchase of machine tools and other equipment. The purchases will be made by A.E.I. in the United Kingdom and, to a certain extent, in European countries which are members of the European Payments Union. The project will be executed in a phased manner and the first phase is expected to cost about Rs. 21 crores during the Second Plan, that is, by the end of March, 1961. Messrs. A.E.I. will act as technical consultants for the whole of the project, with Messrs. English Electric as consultants for turbines.

As a first step the factory will be designed for the manufacture of the following items :

(*a*) A.C. rotating machinery : a.c. generators, water-wheel driven, up to 50,000kW capacity ; a.c. synchronous condensers up to 15,000kVA ; a.c. generators for diesel sets up to 500kW ; a.c. industrial motors above 200 h.p.

(*b*) D.C. rotating machinery : d.c. traction motors up to 600 h.p. ; d.c. motor generator traction sets up to 30 h.p. ; d.c. generators and motors up to 5000kW ; d.c. welding generators up to 10kW.

(*c*) Rectifiers : rectifiers for railway electrification (stationary and mounted on rolling stock) ; industrial rectifiers.

(*d*) Transformers : power transformers of all voltages from 33kV up to 220kV ; voltage and current transformers ; transformer type voltage regulators ; rectifier transformers.

(*e*) Switchgear ; a.c. medium voltage metalclad oil circuit breakers ; a.c. metalclad isolators (6·6kV–11kV) ; a.c. outdoor 22/33kV oil circuit breakers, 500MVA and 750MVA rupturing capacity ; a.c. outdoor 66kV oil circuit breakers, 3-tank, 750/1000MVA rupturing capacity ; a.c. outdoor 110/132kV oil circuit breakers up to 5000MVA rupturing capacity ; 220kV outdoor air-blast circuit breakers, 5000–7500MVA rupturing capacity ; 25kV oil and air-blast circuit breakers for traction ; d.c. traction high-speed circuit breakers, 1500/3000V ; surge diverters of voltages up to 220kV ; traction and industrial control gear.

(*f*) Static capacitors : 400V–3000V.

(*g*) Water turbines : Up to 50,000kW.

Annual production capacity for all items has not yet been assessed but it is expected that the following schedule will be maintained : hydraulic turbines and generators, about 175,000kW per annum ; generators for diesel sets, 34,000kW per annum ; transformers, 33kV and above, 50,000kVA per annum ; a.c. industrial motors (200 h.p. and above), 50,000 h.p. per annum.

German Mining Exhibition

At the fifth German mining exhibition to be held since the war (September 13 to 28 at Essen) over 500 German and foreign firms showed a very full range of equipment, including the products of the ancillary industries. The exhibition, which was well attended by experts from all over the world, was characterised by a high proportion of innovations, mainly in the direction of increased mechanisation and automation.

DURING the period September 13–28 the German Mining Exhibition was held at Essen, in the centre of the Ruhr coalfield. The largest of the series, this year's show occupied twenty halls with a total area of 60,000 square metres together with 90,000 square metres of open-air sections, with the participation of over 500 firms from Germany and abroad. The four-year interval at which these exhibitions are now held affords the necessary time for improvements and innovations to be produced, and the large proportion of those among the exhibits was very gratifying to the public of whom over 100,000 attended during the first six days. Among them the preponderance of experts over sightseers was quite remarkable although a large percentage of the people in the district are in one way or another connected with the mining industry, and might therefore be expected to evince interest in such a show. Such interest was indeed amply demonstrated by the numbers of schoolboys and young people, including students, who came to the Gruga Park exhibition site.

Trends towards increased mechanisation and even automation were much in evidence among the equipment on show. This development which is fairly general in all coal-mining countries is the national consequence of the need to maintain output and productivity, with an ageing labour force, from increasingly deeper and often poorer seams. Compared with depths of 100m in the U.S.A. and 300m in Great Britain the Ruhr workings have now reached an average depth of 700m, and some mines are substantially deeper. The high temperature at such levels reduces the permissible working time, or alternatively enforces the installation of special air-conditioning plant. Impelled by the shortage of underground labour and increasing cost of wages, the development of coal-cutting and handling machinery, as well as of the mechanical roof support, is proceeding rapidly, in spite of the special difficulties created by the thin German seams.

Some interesting figures about coal production were presented in the special show "100 Years of Ruhr Coal" at the Mining Exhibition. With a labour force of 476,000, of whom 327,000 worked underground, the Ruhr coal mines last year produced 130,800,000 tonnes. But productivity, at 400 tonnes per man-year, was only 50 tonnes per man-year above the figure for 1948, and that rate—350 tonnes per man-year—was first attained as early as 1900. Although after the first world war there was a setback to 150 tonnes per man-year in 1920, by 1933 an output rate of 500 tonnes per man-year had been reached which was even further expanded to a peak of some 550 tonnes in 1938.

Coal-Face Equipment and Roof Supports

Gewerkschaft Eisenhütte Westfalia in developing further its coalploughing devices, has evolved an "activated" plough for tough coal, for use with a "panzer" conveyor, the edge of which carries a tubular guide rail. The chain-drawn plough is fitted with an air turbine which vibrates the cutter bits at the rate of 1200 oscillations per minute. With a cutting depth of 500mm, the travelling speed of this design of plough is lower than normal and the chain drive has to be fitted with a special reduction gearbox. The ram plough is normally used for working very thin steep seams without support and stowage. Its body is shaped so that it tends to be pulled into the coal-face where its kinetic energy is spent in driving in the cutters at high speed. Also intended for steep seams is a circular disc cutter plough, in which the disc is rotated by an air-turbine via a reduction gearbox. All these ploughs are laid out for cutting both on the forward and the return stroke. Among other equipment by this firm we noted a range of hydraulic rake loaders mounted on crawler tracks.

A coal cutter and loader specially designed for thin seams was exhibited by Maschinenfabrik Korfmann G.m.b.H., Witten (Ruhr) (Fig. 1). The 80kW machine operates in either direction under the action of an 18-ton hydraulic winch which gives infinitely variable feeds of up to 3m per minute. The rotating cutters deliver the coal to the cutting and discharge chain behind, which feeds it to the face conveyor.

The importance of technical advances in supporting the roof is underlined by the fact that in Germany alone 220,000 tons of steel profiles are used annually for the construction and repair of mine galleries. Some 15 per cent of all underground work, or 45,000 man-shifts per day, representing over DM.1,000,000 in wages, are concerned with the advance and maintenance of adits. It is clear that substantial savings can be made by rationalising this side of the miner's work.

Several firms showed mechanised systems of roof supports. Amongst them were the 4- and 6-prop frames demonstrated by Hoesch-Werke A.G., Dortmund. The individual props are designed for setting loads of 20 to 40 tons, generated by 200 atmospheres of oil pressure, but when lowered can withstand buckling loads of 180 tons. The props of each frame are arranged in two parallel groups of two, or three, and their spherical ends sit on flexible skids made of spring steel, one skid on each side. The tops press against box section bars, front and rear bars being connected by flexible bar springs. Between the two rows of props is the control unit, also flexibly connected to the skids by means of the horizontal shifting cylinders, and carrying the single control lever by means of which the setting and removal of the props on each side and the horizontal movement, is actuated. The bars can be supplied with 1·25m overhang on the face side and also if required on the job side, together with hand- or hydraulically-operated extension bars giving a further 65cm. Shifting power is 10 tons, and the maximum movement of 65cm can be carried out in forty-five to fifty seconds. The frames can cover working heights from just over 50cm to 2·8m, and when set are independent of the supply lines. Of particular interest was the demonstration of the remote control of a group of frames in a steep seam. Since the frames push the face conveyor and cutter before them, and carry behind them wire mats for blast stowing, the set-up is completely mechanised under the control of one man at the filling station. Large-scale tests have been carried out in two mines since the beginning of last year, and the remote control system is stated to have been under test since May.

A. Beien, Herne/Westphalia, exhibited a face-working automatic, comprising a double line of pneumatic-hydraulic props, face conveyor and two coal ploughs, the main plough at floor level and an auxiliary plough at roof level to cut down the coal overhang. These ploughs are guided on rails attached to the conveyor face side and support bars respectively. Pipes for blast stowing are slung from the job bar ends of the rear props. The cutting and advance is programme controlled.

A novel design of prop has been introduced

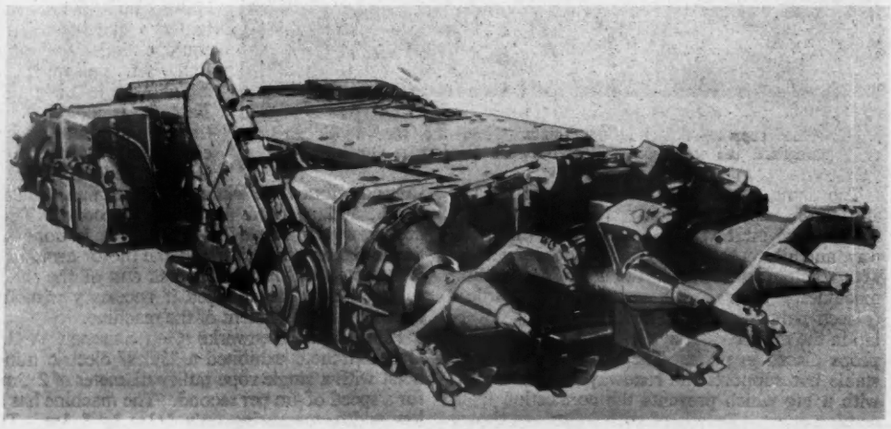


Fig. 1—Combined coal cutter and loader—Korfmann

by Gutehoffnungshütte Sterkrade A.G., comprising two square telescopic sections, one sliding inside the other, which are tensioned and locked at the required load (say, 25 tons) by a hydraulic friction lock. The same firm showed a double-telescopic prop for thin seams which can be extended from 415mm to 750mm length, or 1m with extension pieces. The prop is fitted with mushroom cap and base and can be set to loads of 20 to 30 tons. A light-weight, 12-ton capacity prop, specially designed for steep seams, and made from thin wall hexagonal alloy steel tubing, is stated to have nearly the same low weight as a corresponding light alloy prop.

Gewerkschaft Eisenhütte Westfalia, Wethmar/Lünen, also introduced a mechanised roof support comprising a double line of hydraulic props of 20–30-ton setting load, 40-ton carrying load, which are arranged in frames of two props joined by a tie-bar. Adjacent frames are connected in pairs by the hydraulic shifting cylinders. The whole assembly is operated by a central unit containing a high pressure oil pump and a very high pressure pump. The frames advance in short steps, taking about ten seconds each time, and are adaptable for roof heights from 0·8m to 2·1m.

Johann Usspurwies G.m.b.H., Duisburg, demonstrated a support frame for 10 to 21 square metres drift section and over and seams up to 3·5m thick, which is built up of the required number of box section steel units flexibly jointed at the ends without the use of bolts, into a complete circle or ellipse. As a test in a hydraulic rig showed, loads applied at any joint are satisfactorily distributed over the whole of the ring. For holding-in any unsupported corners temporarily, during construction or before stowing has been completed, adjustable tie-rods are supplied. By means of a special hydraulic jack, rolling can be carried out from a safe distance by pulling inwards one corner of a special element and so collapsing the frame.

In the Usspurwies-Hagen system of roadway construction, which was demonstrated, the stowed rock behind and between steel arch supports is solidified and joined with the steel by injecting a special colloidal cement mortar. This, it is stated, gives a structure which is strong enough to support the load under plastic conditions and yet is an economic method of building.

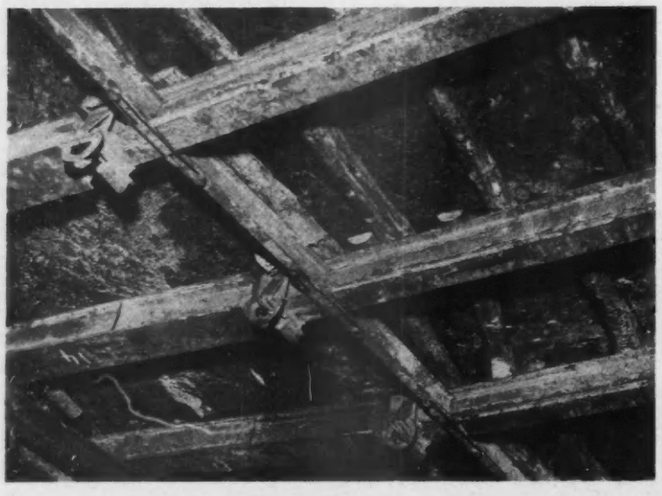


Fig. 2—Roof supports linked by lug joints. Note the wire loops used to safeguard the cross-connections—Johann Usspurwies G.m.b.H.

The same firm also exhibited its road-head and stable support, which enables the machine stable to be built at the same time as the roadway, and allows the two to be advanced together, with resultant efficiency in the use of the loading machines. The roof is supported by girders (placed parallel to the roadway axis) which overlap in the middle. They rest upon early-bearing props placed in pairs. The forward end of the stable bar supports the roadway bar by a joint with a lug which prevents the connection from coming apart. Details of such joints are shown in Fig. 2. Roadway props are set on the dip side. The drive units stand under the cantilever-supported roof and are easily accessible from all sides. Early bearing props prevent the roof at the face entry from breaking away, reduce convergence and give more room for the drive units. The unsupported area is now at the narrowest spot above the conveyor. As the face advances, the stable props are removed here and reset immediately behind the conveyor. Permanent props are set at the ripping lip as the stowing proceeds.

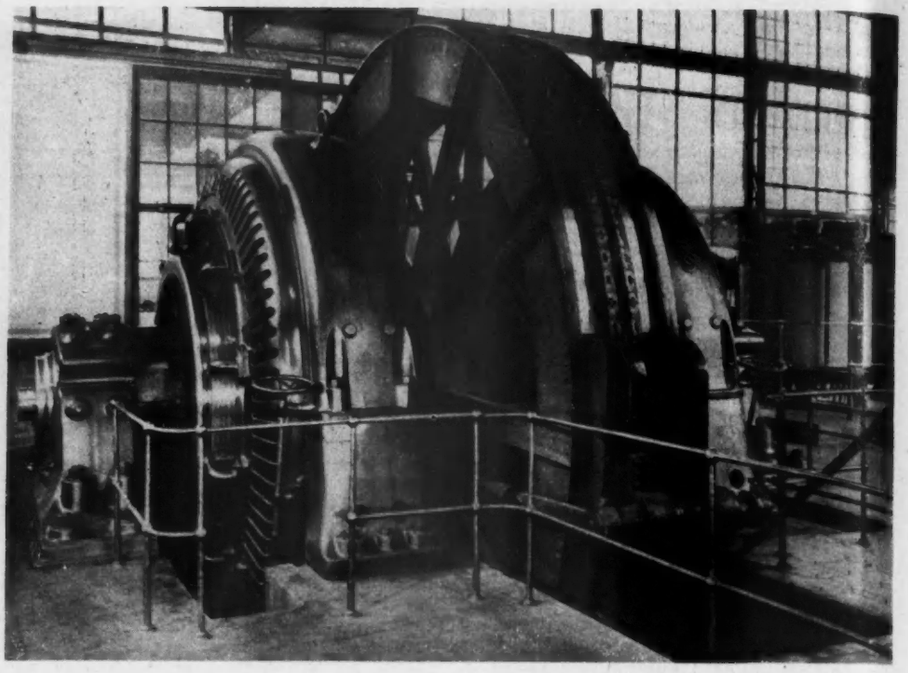


Fig. 3—Direct-driven d.c. colliery winder (1902). Depth 464m, payload 6600 kg, speed 10m per second, maximum static load on rope 24,000 kg, pulley diameter 6000mm, motor power 2×750kW—Eisenwerke Mulheim/Meiderich A.G.

Hoists and Winches

Rheinstahl Eisenwerke Mülheim/Meiderich A.G., Mülheim (Ruhr), showed the mechanical part of a direct-driven d.c. winder (electrical part : Brown Boveri) for 10-ton useful load, 1000m depth, and a speed of 18m per second. The diameter of the single rope pulley is 7m, and the shaft is supported in three bearings. A similar machine, with electrical equipment by Siemens-Schuckert-Werke, is illustrated at the top of page 621.

Two models on the stand of this firm were also noted. One showed the first electric colliery winder, the electrical equipment being supplied by Siemens and Halske, built in 1902 for battery starting but equipped in 1904 with an Ilgner set. This machine is shown in Fig. 3. This, it is stated, was the first machine to be equipped with rectifiers (1937). The other model showed a four-rope winder for 18 tonnes, 1200m depth, and a speed of 18m per second. This design uses a single brake ring, as is done in Anglo-Saxon countries, and the motor armature is mounted on the cantilevered end of the shaft so that it can be changed if necessary without upsetting the alignment of the machine.

Rheinstahl Eisenwerke Gelsenkirchen A.G., Gelsenkirchen, exhibited a 230kW electric mine hoist with a single rope pulley diameter of 2·5m, for a speed of 4m per second. The machine has a low width, measuring only 3·1m by 8·1m. To achieve this, the motor is set at right angles to the pulley and the gearbox is arranged to float on the motor and pulley shafts. The main shaft is supported in two bearings at its ends which rest on a torsion-resisting frame. Another hoist design built on the unit system was powered by two 42kW pole-changing squirrel-cage induction motors. Gearbox and motors can be arranged on the right or left of the control position, according to local requirements, and between the gearbox and pulley there is a flexible coupling.

An improved design of haulage winch was shown by Maschinenbau Volkert, Witten-Annen. The 6-ton version has a length of 3250mm and a width of only 800mm, so that it can readily be placed between adjacent tracks. The rope which enters and leaves at track level passes over two grooved drums in several turns, thus preventing slip and lateral rubbing. A 28 h.p. motor drives the winch through a hydraulic coupling at 20m per second, for slow speeds an auxiliary 4 h.p motor is provided with additional 1 : 8 reduction. The brake is oil-operated. The equipment includes sprung rope reversing pulleys with take-up of stretch.

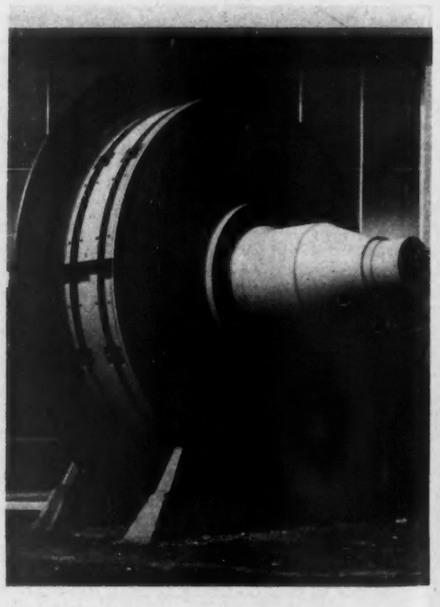


Fig. 4—Two-rope winder pulley with flange-mounted electric rotor and disc brake, supported in two roller bearings at the ends—Eisenhutte Prinz Rudolph

Means for adjusting the length of hoist ropes while under load have been developed by Hever Hammer, Grüne/Kr. Iserlohn. The rope attachment is held by a screw spindle which is loaded in compression, and which may be rotated through reduction gearing by means of two manually operated ratchet levers. Both the spindle and gearing are totally enclosed and protected. As an optional addition, a motorised drive for the adjustment is stated to be under development.

With a view to reducing the weight and width of the hoist frame, what is claimed to be the narrowest hoist design to date has been produced by A.G. Eisenhütte Prinz Rudolph, Dülmen. Our illustration, Fig. 4, shows the rope drum with which the motor is directly connected. Towards both ends, the hub reduces in diameter to the size of the two outer bearings which take the form of roller bearings. Particularly noteworthy is the use of a disc brake. This design, it is stated, has been applied to an important installation of 1100m depth from which net loads of 18,000 kg are hoisted at 14m per second, with a motor rated at 3200kW.

Electrical Equipment

Allgemeine Elektricitäts-Gesellschaft, Berlin-Grunewald, showed a liquid starter for three-phase winder motors which is operated electro-hydraulically (Fig. 5). The liquid resistance in series with the rotor follows steplessly the position of the hand control lever. The voltages from a tachogenerator coupled with the motor, and from an inductive transmitter coupled with the control lever, are compared in the speed control unit and their difference actuates a control valve which operates a hydraulic cylinder to which are attached the moving electrodes of the liquid starter. A second inductive transmitter attached to the electrode system feeds a stabilising voltage back to the speed control unit.

Cables with corrugated steel sheath to replace lead sheathing have been in use for many years. A further step has now been taken by Hackethal Draht- und Kabel-Werke Aktiengesellschaft, Hanover, which has produced a cable, the sheath of which can be used as a fourth conductor. For this purpose it is made of corrugated copper, supplemented, if an extra large cross section is required, by a layer of bare copper wires underneath the sheath. The corrugations are covered on the outside with compound and the whole is sheathed in polyvinyl chloride. Besides being very pliable along its length and resistant to deformation of its section, the cable is stated to be substantially cheaper than lead-sheathed cable of the same capacity. The exterior position of earth conductor, if the copper sheath is used as such, greatly facilitates the installation. Connection is made simply by soldered or clamped terminals, the latter at the same time prevent the cable from being pulled out of the junction box or other housing.

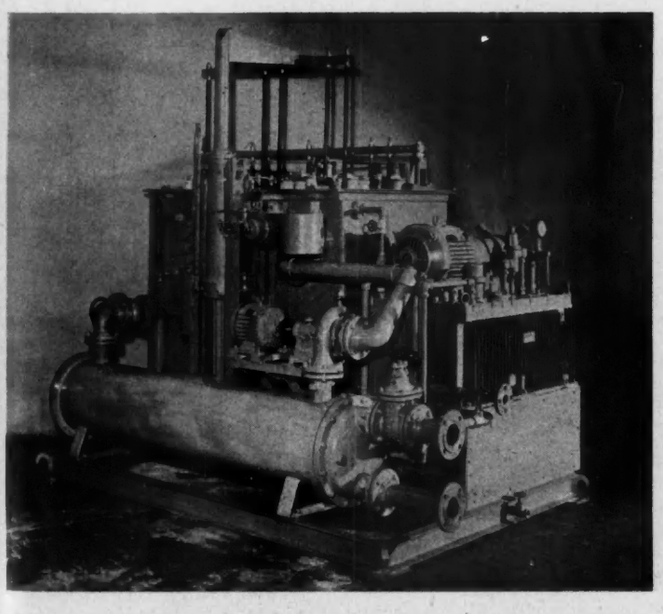


Fig. 5—Liquid starter and electro-hydraulic controls for three-phase induction motor drive for colliery winder—A.E G.

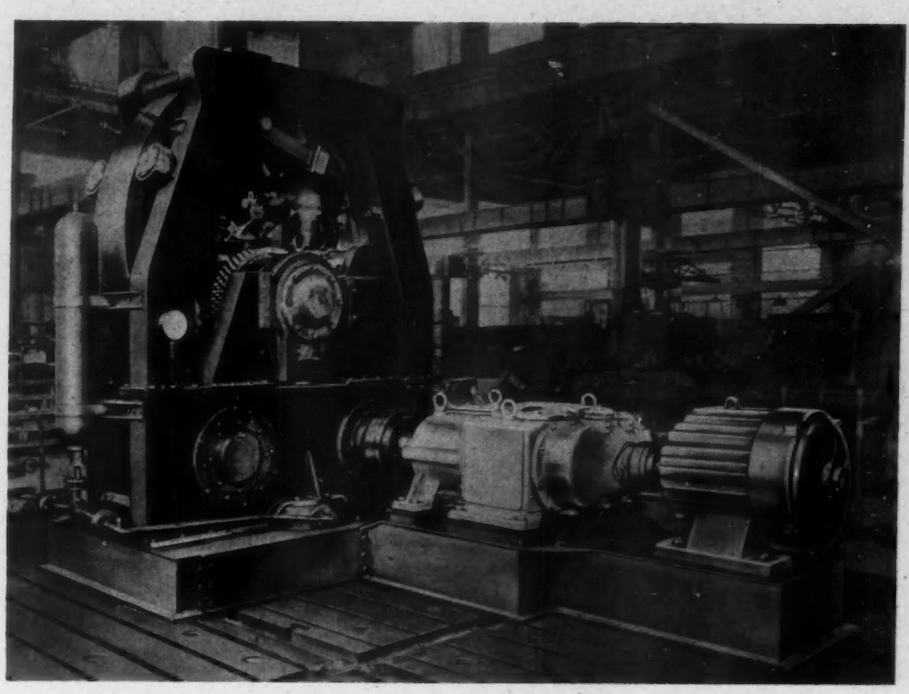


Fig. 6—Ring roller briquetting press—Buckau R. Wolf

For surface and underground use in mines, iron works and related industries, Ruhrdynamo G.m.b.H., Duisburg-Meiderich, exhibited a welding locomotive (Fig. 7) of 7·5kW driving and 12·5kW welding capacity, operating on 220V d.c. The engine measures 2300mm over buffers (special short design, 1800mm), weighs 2300 kg, and is designed for a speed of 9km per hour. By means of a clutch, the driving motor can be used for powering the welding dynamo, which has two current ranges covering 50A to 300A. A separate 100W generator supplies the lighting and signalling device. Besides constituting an automotive supply of welding current, the engine can pull six to ten trucks or carriages.

Standard Elektrik Lorenz A.G., Stuttgart, demonstrated a variety of applications of its transductor magnetic switch. In this device, a relay is placed in series with a choke operated near magnetic saturation. By increasing the flux, e.g. by a permanent magnet, the reactance of the choke is decreased, and a current flows in the circuit which operates the relay. A differential arrangement of switches was used for indicating the position of a hoist cage to within ±1cm by means of a permanent magnet fitted to the cage at a distance of several centimetres from the switch magnets. The switch is explosion-protected and can be supplied in various sensitivities to suit the application. A novel axle counter was shown in operation on a short length of rail track. Especially in mines mechanical counters are liable to damage from rough usage, dirt and water. The present design uses a magnetic switch with hermetically sealed contacts ("Hercon" switch). The contacts are mounted on flat springs made from magnetic material which adhere under the action of an external magnetic field and so close a relay circuit. A permanent magnet provides the external field; the magnet is attached to a flat spring which is depressed by the tyre rim as a wheel passes over it and approaches the "Hercon" switch.

The company also showed a transistorised telephone and signalling installation for use between the hoist cage and engine-room. By virtue of the feeble currents employed the installation is stated to be intrinsically explosion safe. Besides speech transmission three signal frequencies are available, allowing, in the case of double winders, the use of different bells for the two cages; and by combining these frequencies permitting the use of passenger-operated controls as in normal personnel lifts. The transmission is carried out inductively by way of the top and bottom hoist ropes. The cage installation comprises the amplifier, microphone with signalling key, and separate loudspeaker. Signals are recorded in the engine-room and automatically verified by signalling back to the cage loudspeaker. In addition, an alarm is sounded when

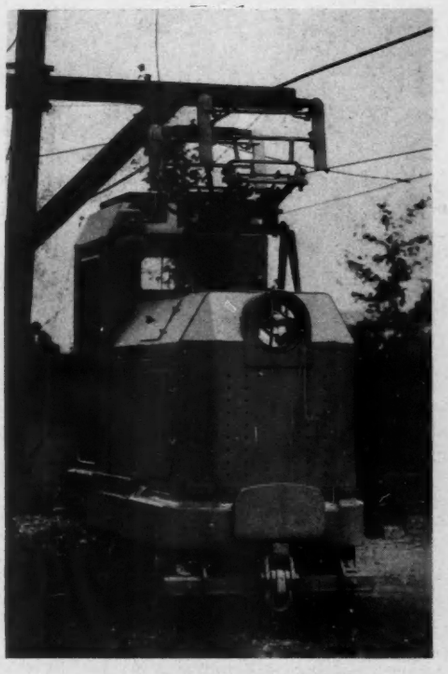


Fig. 7—Welding locomotive for 220V, d.c., and 7·5kW (driving), 12·5kW (welding). Length over buffers is 2300mm, weight 2·3 tonnes, maximum speed 9km per hour—Ruhrdynamo

a special emergency frequency is interrupted either through a failure of the installation or intentionally by pressing the emergency button.

Coal Treatment, Handling, Ancillary Equipment

Shown in model form, the " Wemco " flotation drum by Maschinenfabrik Buckau R. Wolf, Grevenbroich-Neuss, is designed for the heavy liquid separation of coal or ore up to sizes of 250mm and from 5 tons to 700 tons per hour. The drum carries lifting blades over its whole length and so is stated to maintain a high output even when the proportion of waste is large. For three-component separation, two separators can be arranged inside a single drum, with resulting saving of space ; there are no moving parts inside the liquid. Fig. 6 shows a ring roller press made by the same firm, for the briquetting of coal, salt, ore and metal powder. Such machines have been built with capacities up to 5 tons per hour and ring thrusts of 200 tons, for pressures of 2000 kg per square centimetre and over. Projected versions are said to be on the board with capacities up to 20 tons per hour and ring forces of 1000 tons.

Rationalisation of underground transport is the object of a complete system brought out by Maschinenfabrik Heinrich Scharf G.m.b.H., Wuppertal-Cronenberg. This comprises a range of containers for use on mine railway bogies. These containers are supplied with or without lid, plain or with end door and tipping arrangement, flat deck, or special superstructures for the transport of pipes and structural components. Provision is made for lifting by hand, crane, or fork-lift truck. The bogies have a rotatable top on which the containers are placed which carries inside it a sliding ramp fitted with rollers. This allows the bogie to be unloaded by hand, using a small hand-operated winch for the purpose. Alternatively, the containers can be hoisted on to the double-winch crab of a universally jointed monorail and transported in this way. Equipment shown by this firm included a silo container for rock dust which can be carried either on the normal bogies or on a special truck for filling rock dust stages. This has a superstructure which can be tilted through 20 deg., thereby tipping the silo contents into the inlet of a motor-driven screw conveyor which can be luffed and slewed to reach the point required.

Fig. 8—Rail-borne " caterpillar " conveyor which may consist of up to about 100 units, each 1m long and connected to the next by a rotatable drawbar. By driving it through a tipping track section, the caterpillar is discharged—Becker and Prünte

An ingenious innovation was the rail-borne " caterpillar " conveyor (Fig. 8) by Becker-Prünte G.m.b.H., Datteln/Westphalia, for bulk materials of all kinds ; it combines features of the belt conveyor and an ordinary train of tubs. It consists of a leading truck and a number of 1m long units, each of the latter comprising a single axle and tray-shaped body and coupled to the next section by means of a drawbar which can rotate about its own axis. The trays are linked by lengths of sheet rubber which for economy's sake can be made from old conveyor belts. The first and last trays are closed by end plates at the free end. Up to 100m of conveyor can be assembled in this way and the whole train propelled (at up to 2m per second) from either end by a locomotive, chain-drive or cable. The conveyor is discharged by passing it through a tipping section (by-passed by the engine) which tips the tray sections in succession to a discharge angle of 45 deg. The amount of tip depends upon the angle which the side of the tray makes with the axle, e.g. for 90 deg. of included angle a tipping movement of 135 deg. can be carried out. This is stated to ensure complete discharge even with clogging materials.

The same system of tipping can be applied to tubs but since in the inverted position the wheels on making contact with the hold-in rails would be reversed, with consequent shock and additional wear, use is made of an extra set per axle of freely rotating hold-in wheels. The gap between trucks is covered by tiltable sheet metal shields so as to facilitate loading from conveyors.

A starting coupling, the automatic engagement of which can be adjusted to suit the nature of the drive, was exhibited by Flender, Bocholt. In this design, the connection between the driving shaft and a vee or plain pulley mounted on it (or between two co-axial shafts) is made by friction jaws under centrifugal action. On starting, the motor reaches full speed quickly, while the engagement of the jaws is retarded. This is done by seating the jaws in a double taper housing, one-half of which is expanded against oil pressure as the jaws move outwards, forcing the oil through an adjustable orifice from one membrane space into another. By spring-loading the outer membrane and providing a full-bore non-return valve for the return flow of the oil, the initial fully disengaged position of the coupling is regained immediately the drive stops. Since the delay period depends on the rate of oil flow through the restriction the coupling can easily be operated over a wide range (three to sixty seconds delay, or more) simply by varying the degree of opening of the needle valve by which the orifice is controlled.

Self-lubricating rollers for belt conveyors and wheel sets for chain-driven plate conveyors were shown by Rolandwerk Oberhausen (Rhld.) These items have plain bearings fitted with sintered bushes. The pressed steel housing which surrounds the bush is hollow and forms an oil reservoir sufficient for many years to replenish the oil in the self-lubricating bearing. On the outside the bearings are protected by a labyrinth or U-rubber seal. It is stated that the bearings require no maintenance throughout their long life

Jointing hooks for conveyor belts which are fitted with a sealing strip which automatically seals the joint against coal grit and dust have been put on the market by Nilos G.m.b.H., Düsseldorf.

Hydraulic equipment for assembling and dismantling press fits has been supplemented by the design offered by the firm Hans Heidkamp, Velbert (Rhld.). This covers a range of hydraulic cylinders of from 9 tons to 90 tons capacity, together with oil pump for 700 atmospheres, high pressure hose (tested to 1200 atmospheres), and quick-action coupling which is hand-operated and permits the pump to be removed with the cylinder under pressure, without loss of oil. The ram has a central bore through which anchor bolts may be passed for press-on work. Various crossheads may be used with the cylinder, e.g. in connection with the removal of wheels from shafts.

A safety lubricator for inclusion in compressed air lines, by Emil Pleiger K.G., Sprockhövel/Westphalia, contains an oil reservoir in which the oil is kept under pressure by means of a piston exposed on its other face to the air pressure. The oil is forced into the airstream in the form of an oil mist. As it is used up, the piston descends and eventually shuts off the air supply which can only be restarted by filling the reservoir. The lubricator is made to fit lin to 4in diameter or 25mm to 100mm diameter pipes with oil contents of 400 c.c. to 1000 c.c.

For mixing dry powdered chemicals and minerals, Engels and Ritter O.H.G., Bochum-Langendreer, has developed a mixer which it is claimed has an improved performance over traditional designs. The mixer comprises a container of tetrahedral shape with filler cap at one corner which is slowly rotated about an axis through its centre of gravity. There are no internal blades or shafts. Mixing occurs through the transfer of the material from one side of the tetrahedron to a corner and back to a side again. This three-dimensional to and fro flooding is stated to be superior to other mixing processes which are mainly two-dimensional. Machines are available in sizes from 20 to 200 litres and over, with metal or transparent plastic containers.

Television for Traffic Control

An installation for the remote control of traffic by means of television has recently been installed in Munich. It serves the Stachus, one of the most important cross-roads in the centre of the Bavarian capital, and a locality where traffic jams used to be a frequent occurrence. By means of a Grundig " Fernauge " industrial television camera, the policeman on duty at the 800m distant prefecture can survey the various traffic lines and set the control lights accordingly. The camera is mounted on a 16m high mast at the corner of one of the roads coming from the main railway station. It can be rotated through 270 deg. and also inclined down to about 30 deg. below the horizontal. By means of a lens system with continuously variable focal length, the field of the camera and the magnification can be adjusted to what is momentarily required. Positioning and adjustment of focal length is carried out by means of a control stick like that of an aircraft. Deflections of this stick in the horizontal plane cause movement of the camera, while a rotation varies the focal length between 17mm and 68mm, and hence the angle of the field between 35 deg. and 8 deg. No manual adjustments are necessary of the electrical settings which are automatically corrected by the camera. It is claimed that not only will the traffic policeman be able to see more with the help of the television camera than before, he will also be able to work under comfortable conditions unaffected by weather extremes, so that his work will be less subject to fatigue.

Salzgitter Shipyard at Berlin

The shipyard of Deutsche Industrie-Werke A.G., Berlin–Spandau, where the first construction, a 1000-ton motor freighter, was launched in August, belongs to the Salzgitter group. This yard occupies about a tenth of the works area of 400,000 square metres and has a main hall measuring 90m by 68m in which eighteen ships can be built annually on two slipways. There is a 200m long fitting-out quay with 35-ton crane, as well as a 90m long repair slipway, capable of taking at a time four ships of 9·5m beam which is three-quarters complete. The yard, which employs 180 people, will serve to supplement the production programme, hitherto limited to foundry work, carriage building and mechanical constructions.

Ottensener Eisenwerk A.G. Shipyard

On September 20 there took place the launching of the bauxite transporter " Olin," 16,000 tons deadweight, at yards at Hamburg-Steinwerder of Ottensener Eisenwerk A.G. This is the first large cargo vessel from this yard which has only recently been completed.

Progress in Controlled Thermonuclear Research in the United States

BY OUR AMERICAN EDITOR

No. II—(*Continued from page* 587, *October* 10)

During the past seven years the U.S. Atomic Energy Commission has been engaged in a research programme aimed at producing power from controlled nuclear fusion. The research effort is necessarily shaped by the physical conditions that must be achieved in order to realise net power from fusion. These physical conditions apparently have been defined, and promising methods of achieving them have been formulated. Significant progress has been made along several lines of effort ; each is contributing knowledge to the art of controlling fusible material for the achievement of a self-sustaining thermonuclear reaction. This article describes some of the more important classes of experimental devices developed at the four major laboratories working in the field and the principles and methods applied in these machines to overcome the two fundamental problems of attaining extremely high temperatures and of confining the plasma.

THE extraction of fusion energy becomes a vital objective of the programme once ignition temperatures have been attained. Since a considerable portion of the nuclear energy from fusion reactions is released in the form of kinetic energy of charged particles, direct production of electricity may be possible without the intervening step of extracting heat to operate a turbo-generator. For example, the charged particles can be made to react with a confining magnetic field in such a way as to feed energy into the field and thereby into the electrical system which produces it. The neutrons produced in the fusion reaction will immediately escape from the reaction zone and may be slowed down to thermal energies and captured in a suitable blanket material, such as lithium–6. The moderating action will yield heat as will the capture process which, in the case of lithium–6, could produce tritium as fuel.

Large amounts of energy will be deposited on the walls of the reaction vessel, primarily as a result of radiation from the plasma and also by particle bombardment.

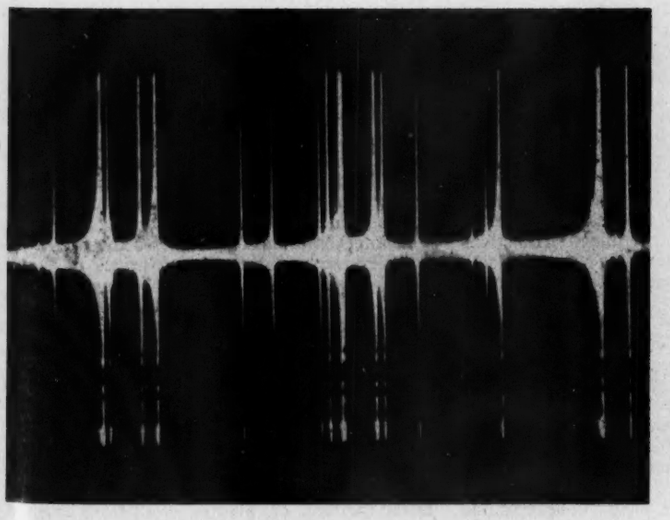
The problems associated with observing the detailed behaviour of a hot plasma are very complex, particularly if conditions in the plasma are changing rapidly. It is difficult enough to create a hot plasma in the first place ; to find out what is occurring within it, once created, is even more difficult. Diagnosing and analysing the plasma taxes the experimenter's ingenuity, and a number of new techniques have had to be developed. To obtain information about the plasma, experimenters probe the plasma with beams of millimetre-range microwaves, measure microwave noise from the plasma, study the emission of X-rays from the reaction region, observe the energies and direction of flight of particles escaping from the plasma (particularly the neutrons), employ high-speed photographic techniques, make spectroscopic measurements, insert probes into the reaction zone to measure electric potentials and magnetic fields, and employ many other techniques. Since particle densities can usually be determined with reasonable accuracy in an experiment, the neutron yield from a hot plasma can be a precise measure of the temperature, provided that the plasma is in a semblance of thermal equilibrium. However, the interpretation of neutron measurements can be misleading at temperatures below about 10,000,000 deg. It is easy for a small number of deuterons, preferentially accelerated by some process which has little or nothing to do with temperature, to produce a close simulation of the neutron yield from an equilibrium plasma. At this stage of the programme, neutron production is of interest only in so far as it can give more information about the plasma than the simple fact that fusion reactions are occurring somewhere within it.

The adverse effects of impurities coming into the plasma from the walls have already been mentioned. In the attempt to obtain clean systems, the controlled thermonuclear research programme has been responsible for interesting advances in the field of high-vacuum technology. As the operating power levels of the experimental devices increase, wall-connected problems will in many cases become more and more severe, because more and more energy will be deposited on them. Eventually, of course, it will be necessary to cope with the radiation damage produced by very energetic neutrons bombarding the walls and structure outside the reaction vessel, and with chemical problems associated with neutron-absorbing blankets. Preliminary studies are being made of these problems. The most serious problems at the moment, however, are those connected with the proximity of material walls to the plasma and the density of undesirable neutral particles.

The Pinch Programme

The electromagnetic phenomenon commonly referred to as the "pinch effect" has been known to scientists for a long time, but it was only a few years ago that they began studying it in connection with electrical discharges in gases and as the basis for an approach to controlled thermonuclear reactions. Research programmes along these lines were initiated at the Los Alamos Scientific Laboratory in 1951 and at the University of California Radiation Laboratory in 1952.* In the pinch approach, confinement of the plasma is achieved through magnetic fields which result from current flow within the plasma itself. Heating occurs as a result of current flow and of compression of the plasma by the confining field. The approach possesses a basic simplicity which has great appeal. It does not require elaborate or expensive apparatus in order to obtain interesting experimental information. However, the pinch programme has had to cope with severe plasma instability problems. Neutrons have been produced in pinch devices under conditions which suggest thermonuclear origin. The results have been encouraging. Nevertheless it is sobering to reflect that the number of neutrons produced (up to about 100 million per pulse) falls

* The British programmes of controlled thermonuclear research were described in last week's issue, page 572.



Figs. 5 and 6—(Left) Spectrogram of a pinch of xenon gas in a "Perhapsatron," showing the broadening of spectral lines at the centre due to increased density and temperature under the maximum compression in the pinch. (Right) Large "Columbus II" pinch machine for controlled fusion research at Los Alamos

far short of representing the return of as much energy as was required to produce them. However, the same general situation would exist for any device operating at the temperatures which appear to have been reached in pinch devices thus far.

As indicated above, the passage of an electric current through a fluid conductor, such as a plasma, in itself produces a magnetic field which acts to constrict or pinch the current channel—in this case, the plasma—down to a slender filament. For example, if a current is caused to build up rapidly in a cylindrical tube containing a gas at low pressure, the current will tend to be carried in a tubular surface layer or sheath. The magnetic field, with circular lines of force concentric with the tube axis, forces the current-carrying sheath to move radially inward, driving the plasma before it. The constriction continues until the magnetic pressure outside the sheath is balanced or momentarily exceeded by the particle pressure inside the sheath. The magnetic field distributes itself in an efficient way ; it is highest where it needs to be high—adjacent to the plasma—and falls off with increasing distance from the plasma column. The magnetic field intensity is proportional to the current ; therefore the magnetic pressure confining the plasma is proportional to the square of the current. It is easy to show that, in order to confine plasma at the temperatures and densities needed for thermonuclear reactions, the currents required are very high, of the order of millions of amperes. Since it is very difficult to provide sustained currents of this magnitude, it is customary to operate the experiments on a pulse basis through the use of large banks of condensers, which can store energy electrically and deliver it in an extremely short time.

Experimenters working with devices of this type soon found that the duration of confinement was severely limited by instabilities. These instabilities, hydromagnetic in nature, had in fact been predicted by Princeton theoreticians before they were recognised experimentally. Two of them, the pinch (or " sausage ") and the kink instability, are illustrated in Fig. 4 *ante*. Both result from perturbations which cause the magnetic pressure to exceed the plasma pressure in some localised region and drive the system away from equilibrium. In the case of the sausage type, the plasma column narrows down in a neck and tends to pinch itself off ; in the kink type, the plasma can be blown into the wall. Sausage instabilities are strongly believed to be the source of neutrons observed in the first simple dynamic pinch experiments. High local electric fields, produced inductively, could accelerate a few deuterons to sufficiently high velocities so that they could bombard and react with other deuterons essentially at rest. It was immediately evident that energy release so intimately related to instability breakup could not lead to useful power.

Ways were found to stabilise the pinch. It was discovered that stability could be greatly enhanced by trapping a relatively weak longitudinal magnetic field (with its lines of force parallel to the axis) and compressing it along with the plasma. This slows down pinch formation time and reduces the compression attainable. The duration of stable confinement depends on how well the magnetic field inside and the field outside can be kept separated since they tend to diffuse into one another, with disastrous results. Intermixing of the fields is opposed by high electrical conductivity (high electron temperature) in the sheath region. The situation is actually a good deal more complex than this simple picture would indicate, and is the subject of intensive study at the laboratories working on pinch devices. The stability of pinch discharges also is improved if the wall material of the tube is a good electrical conductor, or if a conducting material is placed around a thin insulating wall. Eddy currents then act to repel the plasma if a kink develops to push the plasma column toward the wall. Comparatively high pressures can be sustained momentarily in pinch devices before the onset of instabilities. In small devices, pinch durations of a few micro-seconds are typical. However the high rate of power input which can be achieved with these small devices tends to compensate for their small size and their brief operating cycle.

In pinch devices, heating occurs as a result of (*a*) passage of the current (ohmic heating), and (*b*) compressions as the magnetic field drives the plasma in toward the axis. In large, slow, low-density pinches (*a*) predominates ; in small, fast, high-density pinches (*b*) is the more important. In the fast pinch devices the compression may be so rapid that it virtually constitutes shock heating. The temperature of a hot plasma may be measured or estimated in a number of ways. One method makes use of magnetic probes, tiny coils of wire encased in quartz and inserted into the discharge. These probes are used to determine the magnetic field distribution and current distribution as functions of time. The plasma pressure can then be calculated ; the density can be closely estimated, and therefore the temperature can be calculated.

Pinch experiments may be carried out with either toroidal or cylindrical tubes. Toroidal geometry has the great advantage of eliminating problems associated with the ends of tubes. A ring of current travels around the tube. The current is established by induction. For example, a closed iron core is threaded through the hole of the torus. When a time-varying current is passed through a primary winding on the core, an electromotive force is induced in the secondary, which consists of the gas in the tube, and thereby a current is caused to flow. However, the current into the tube cannot continue to flow in the same direction indefinitely because the current in the primary cannot increase without limit. Although the toroidal geometry is generally preferred, linear tubes have some advantages and are therefore used in many experiments. However, there are end losses of particles to be reckoned with, because the current must be passed in through an electrode at one end of the tube, and out through the other end. There is no magnetic confinement of the plasma in the axial direction. Linear devices permit experiment at generally higher current levels, because the electric fields that can be established along the tube by applying a high voltage between the two electrodes are greater than can be induced in a toroidal tube by the transformer action. Also, a cylindrical tube is simpler geometrically than a torus, and some kinds of data can be interpreted more easily. Linear tubes have been used, for example, in attempts to heat plasma so rapidly—by brute force, so to speak—that thermonuclear conditions can be reached before instabilities have had time to develop.

The Los Alamos Programme

The programme at the Los Alamos Scientific Laboratory was initiated in 1951 under the direction of James L. Tuck. The first experimental device, a torus called the " Perhapsatron," was built in 1952. Since then the name " Perhapsatron " has become a generic term for the Los Alamos toroidal devices ; linear pinch devices belong to the " Columbus " series. Presumptive temperatures of several million degrees have been attained in some of the discharges at Los Alamos. Fig. 5 illustrates the spectrogram of a pinch of xenon gas in a " Perhapsatron," showing the broadening of spectral lines at the centre due to increased density and temperature under the maximum compression in the pinch. Neutrons have been observed in several devices and the number produced per pulse is generally in the range from 1 to 100 million. Magnetic probe techniques have been developed to a high degree of excellence at Los Alamos. The magnetic field and the current density have been determined as functions of time, and plasma pressure has been calculated in linear pinched discharges and also in toroidal discharges, which are more difficult to study. This probe method has proved valuable in elucidating pinch phenomena. Interesting results have been obtained during the past year with a high-power pinch apparatus called " Columbus II." In view of the fast rate of growth of instabilities in pinch discharges, this device was designed to permit the current to reach its maximum value in as short a time as possible. Voltages of 50kV to 60kV can be applied to the ends of the tube, which is 10cm in diameter and 30cm long. The high voltage and large condenser bank permit reaching a current of 1,000,000A in about two-millionths of a second. Beginning in 1957, the tube has yielded neutrons at the rate of 10 to 100 million per pulse. The neutron pulse durations are one or two-millionths of a second. Exhaustive tests were undertaken to determine the mode of origin of the neutrons. It was found that the neutrons were emitted from the gas practically uniformly along the tube, except in a small region near the positive electrode. However, careful measurements of the neutron energy distribution showed that neutrons emitted in the direction of the negative electrode had slightly higher energies than those coming out in the opposite direction. This indicated that at least some of the neutrons were probably produced by deuterons travelling at fairly high velocities toward the negative electrode, reacting either with each other or with deuterons at rest. Experiments with this device are continuing. Fig. 6 shows a photograph of the " Columbus II " apparatus.

Interesting experiments also have been conducted in another linear device, " Columbus S–4." The S denotes " stabilised." This device was constructed to study the effects of greater tube diameter and length on the behaviour of the discharge. Magnetic probe measurements showed that there could be circulating currents at certain times during the discharge, with current flowing in one direction just inside the tube wall and in the opposite direction near the axis. Using initial deuterium pressures of 40 microns of mercury, the pressure in the pinched discharge was observed to rise to about 12 atmospheres when the current channel diameter reached its minimum. Particle energies of about 300 electron-volts, corresponding to temperatures of about 3,000,000 deg., are believed to have been attained. Neutrons are produced in this device.

Perhaps the most outstanding recent advance has been the achievement of an apparently fully stable pinch discharge in the " Perhapsatron S–3," which came into operation in December, 1957. The tube diameter is a little over 2in and the diameter of the torus is a little over 1 ft. Under suitable conditions this tube has yielded as many as 1,000,000 neutrons per pulse. The main burst of neutrons occurred in a time of about 2 microseconds, but neutron emission continued for a somewhat longer time. The putative temperature obtained may be as high as 6,000,000 deg., as determined magnetically. The neutron yield is consistent with a temperature of this magnitude, but is too small to permit precise determination of the mode of origin of the neutrons. The pinch is observed to stay well centred in the tube, with only minor undulations. " Perhapsatron S–4," a larger version of the S–3 device, is now in operation, while a still larger device, the S–5, is in the design stage. The S–4 is one of several pinch devices which recently was exhibited at Geneva (see THE ENGINEER, September 19, page 447).

The University of California Programme

Pinch studies were initiated at the University of California Radiation Laboratory at Berkeley during 1952, and at the Livermore Laboratory somewhat later. The work at Berkeley led to a clear demonstration early in 1955 that the production of neutrons from a simple dynamic pinch in deuterium was not due to a thermonuclear effect, but resulted rather from acceleration of a few deuterons by inductive effects during the instability breakup of the pinch column. More stable pinch configurations, as contrasted with a simple dynamic pinch, are being investigated, both at Berkeley and at Livermore.

Among the promising devices being studied at Berkeley are the sheet plasma device or " Triaxial " pinch and the " Homopolar " device. The " Triaxial " device, which is illustrated in Fig. 7, is a pinch configuration in which a cylindrical sheet of plasma is formed by a discharge in the annular space between two concentric cylindrical conductors. The plasma is confined and compressed by the magnetic fields created by current flow in the axial or longitudinal direction, one way in the discharge itself and the other direction in the two concentric conductors. This device has exhibited an interesting pattern of plasma oscillations over a period of several microseconds and produces a substantial neutron yield in pure deuterium. Studies are in progress to increase the yield and

to determine in detail how the neutrons are produced.

The "Homopolar" device, shown schematically in Fig. 8 (and illustrated on page 446, THE ENGINEER, September 19), is one in which the plasma is compressed into a disc by the radial flow of current in a magnetic field which is perpendicular to the direction of current flow. Under these conditions, the plasma experiences a torque and spins much like the rotor of a disc-type homopolar motor. As a result of this behaviour, the homopolar device provides a means of storing energy, like a very low-inductance condenser. The long-time stability of the rotating plasma of about 100 microseconds suggests that the technique may be useful in creating and confining a thermonuclear plasma. To achieve this goal, however, it is necessary to find some satisfactory way of converting the relatively well-ordered ion motion, imparted by the rotation, into random or turbulent motion. Studies with a larger device are being undertaken.

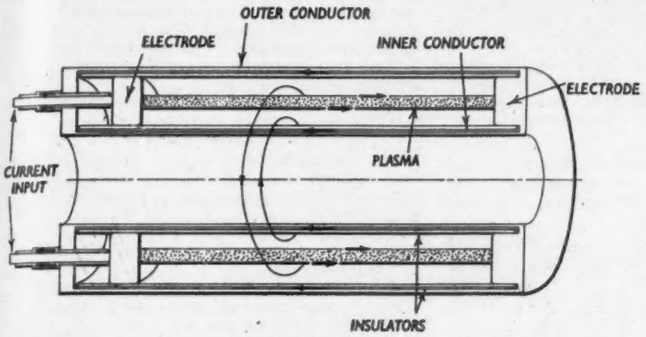


Fig. 7—"Triaxial" sheet plasma pinch apparatus at the University of California Radiation Laboratory

The Livermore programme has been characterised by a continuing effort to understand the mechanism of magnetic shock heating of a plasma and the stabilising effect of an axial magnetic field on a linear or toroidal pinch. Two devices stand out as particularly promising. The Screw Dynamic Pinch is a linear device in which a cylindrical conductor outside the insulator wall is cut with helical or spiral slots, as shown in Fig. 9. The current flowing in this conductor—the same current as that flowing in the tube but oppositely directed—thus follows a helical path. The configuration permits a new degree of control over the type of magnetic field present in the tube as the pinch begins to form. By proper choice of the pitch of the spiral on the outside conductor and suitable adjustment of other parameters, the magnetic fields existing just outside and just inside the plasma boundary can be caused to develop in a way which will minimise instabilities. It is believed that the "sausage" instability can be suppressed, so that a "corkscrew" instability, which is normally slow to develop, will be predominant. If this can be accomplished, it is expected that thermonuclear temperatures will be reached before plasma instabilities develop. The magnetically stabilised toroidal pinch is believed by the Livermore group to be the most promising of the pinch configurations for the ultimate attainment of controlled thermonuclear power, and such a device is shown in Fig. 10. The discharge is stabilised through the use of a conducting tube and the presence of an initial axial magnetic field. Several sizes of small, magnetically stabilised toroidal pinch tubes, up to 10in in bore diameter, have been operated.

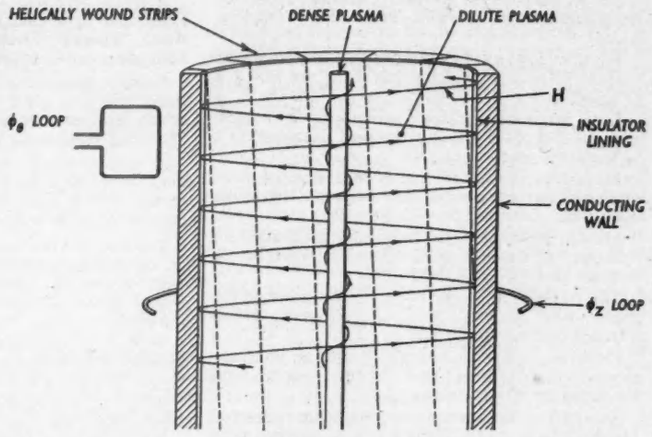


Fig. 9—"Screw Dynamic Pinch" linear pinch apparatus at the University of California Radiation Laboratory

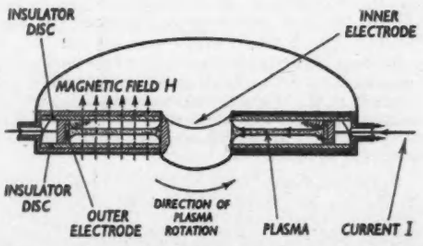


Fig. 8—"Homopolar" plasma compression apparatus at the University of California Radiation Laboratory

(To be continued)

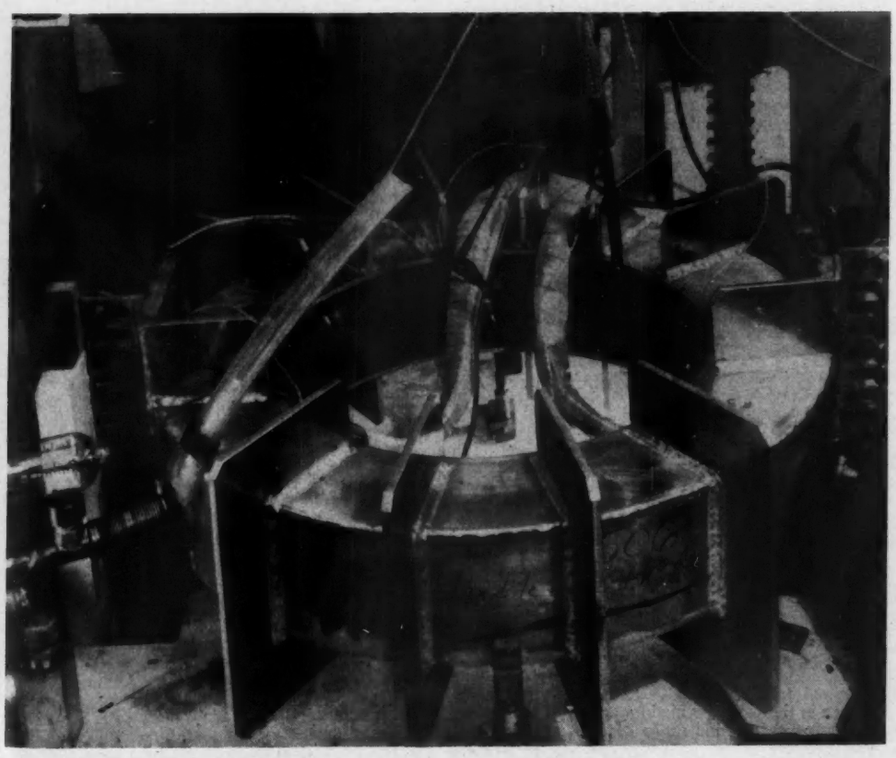


Fig. 10—Magnetically stabilised toroidal pinch machine at the University of California Radiation Laboratory

Metal Sputtering and Printed Circuits

RECENT research into cathode metal sputtering at Bell Telephone Laboratories indicates that this century-old process may be useful in producing precision printed circuits for modern communication equipment. It is possible that entire circuits, including resistors, capacitors, and leads, may be laid down by this technique, in which ionised gas molecules bombard a cathode, dislodging atoms of metal which then redeposit on nearby surfaces. Bell Laboratories have produced thin films of a number of electrically interesting high-melting-point metals. Tantalum and titanium for example, melting at 3000 deg. and 1670 deg. Cent. respectively, can be laid down in films which show sufficiently high resistivity to be useful as resistors in printed circuits. With proper masking of the substrate, lines and patterns of practically any desired shape and size can be formed, ranging in width down to a few mils. These sputtered films generally are between a few hundred and a few thousand angstroms thick and the film thickness can be controlled accurately. Alloys such as those of nickel-copper and nickel-chromium can be sputtered without difficulty.

"Printed" capacitors have also been produced by Bell Laboratories by a combination of sputtering and chemical methods. A tantalum film of the proper shape and size is first sputtered on to the substrate and then anodically oxidised to form a tantalum oxide dielectric film. The counter-electrode, a film of gold, can then be evaporated on to the dielectric to form the completed capacitor "sandwich." Copper leads can be sputtered without difficulty to connect the various components. The technique is attractive since it eliminates the need of any organic adhesives. In cathode sputtering, a plate of the metal to be deposited is used as a cathode. The substrate on which the film is to be deposited is placed on a table close to the cathode. After evacuation, argon or other suitable gas is introduced and maintained at a pressure of approximately 20 to 40 microns. When a voltage is applied, ionised atoms of the gas bombard the cathode, dislodging metal atoms or clusters of atoms, which then deposit on the substrate.

In "reactive sputtering," films of inorganic compounds are formed by introducing a small controlled amount of a reactive gas such as oxygen, nitrogen, or hydrogen sulphide into the apparatus. Oxides, nitrides, and sulphides of a number of metals can be formed in this way.

Personal and Business

Appointments

MR. H. MCPHIE has been appointed administration controller to Charles Churchill and Co., Ltd.

MR. ROBERT WAYNE DEVEREUX has been appointed sales manager of Warwick Production Company, Ltd.

FOUNDRY SERVICES INTERNATIONAL, Ltd., announces that Mr. G. J. N. Cherry has been appointed a director.

LORD WILLIAMS has been reappointed as a part-time member of the London Tranport Executive for a further three years.

MR. H. S. PARSLOW has been appointed sales organiser and manager of the Accurate Recording Instrument Company.

MR. J. H. PROLE has been appointed assistant manager of the mechanical handling division of Babcock and Wilcox, Ltd.

THE HAWKER SIDDELEY GROUP has announced the appointment of Brigadier L. L. Cross as public relations officer to the group.

DR. HAROLD MOORE has been elected an honorary member of the Iron and Steel Institute. He has been a member for fifty-seven years.

THE BRITISH TRANSPORT COMMISSION has appointed Mr. F. J. Lane, M.I.E.E., as a further member of its panel of consulting engineers.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION has appointed Mr. A. Witcomb Smith, M.I. Mech.E., as a member of the Air Transport Advisory Council.

THE PURCHASING OFFICERS' ASSOCIATION announces that Mr. Charles Frederick Huebner has been elected president, and Mr. Walter H. Parry, national chairman, for the year 1958/59.

DR. R. F. WEBB has joined the staff of C.I.B.A. (A.R.L.), Ltd. He will direct the activities of a number of specialist groups engaged in long-term research in new plastics materials.

THE ROYAL INSTITUTION OF CHARTERED SURVEYORS has appointed Rear-Admiral P. W. Burnett to be secretary of the institution, in succession to Sir Alexander Killick, who will reach retiring age next spring.

HEAD WRIGHTSON AND CO., Ltd., announces that Mr. Norman Addison, commercial director of Head Wrightson Iron Foundries, Ltd., has been appointed director and general manager of the subsidiary company.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH has announced that Vice-Admiral Sir Frank Mason, M.I.Mech.E., M.I.Mar.E., has been appointed a member of the Council for Scientific and Industrial Research.

J. D. CROZIER AND PARTNERS, Ltd., announces that Mr. F. C. Thornley has been appointed managing director, in succession to Mr. J. D. Crozier, who has retired from the position. Mr. Crozier is to continue as chairman of the company.

BRITISH TIMKEN, Ltd., announces that Mr. I. F. Fisher has been appointed general works manager, responsible for the management of the factories at Duston and Daventry. Mr. S. H. Jakeman has been appointed works manager at Duston.

G. A. HARVEY AND CO. (LONDON), Ltd., announces that Mr. H. E. Cooper has been appointed managing director and Mr. I. A. Marriott has been appointed to succeed Mr. P. T. Bliss as sales director. Mr. Bliss, who has been with the company for fifty years, is to retire on December 31.

CROMPTON PARKINSON, Ltd., has announced that Mr. P. D. Osborn, A.M.I.E.E., has assumed complete responsibility for the sale of motors produced at its Guiseley factory. He will continue to represent the company in trade association matters. Mr. C. J. Teasdel has been appointed product sales manager, Chelmsford machines, covering large motors, d.c. marine motors, generators and alternators.

Business Announcements

CHARLTON, WEDDLE AND CO., Ltd., Manors Works, Newcastle upon Tyne, has opened a London office at 34, Crutched Friars, E.C.3 (telephone, Royal 1576).

MR. FRANK PERKINS, chairman and joint managing director of F. Perkins, Ltd., is on a good-will and fact-finding visit to Turkey, Greece, Italy, Malta and the Middle East.

MR. J. W. C. MILLIGAN, managing director of Southern Areas Electric Corporation, Ltd., is making a tour of North America. He is examining technical and sales problems associated with the Group's products.

THE NORTHERN IRELAND DEVELOPMENT COUNCIL has announced that Camco Incorporated, of Houston, Texas, U.S.A., is to establish a wholly-owned subsidiary in Belfast.

RUSSELL NEWBERY AND CO., Ltd., Dagenham, Essex, has appointed Raw and Partner, Greendale Road, Woolton, Liverpool, as its sales agents for Lancashire and Cheshire.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that with effect from October 20, the address of its Worcester branch will be 4, Charles Street, Worcester (telephone, Worcester 2070).

ALFRED HERBERT, Ltd., Edgwick Works, Coventry, announces that it has been appointed sole distributor in the British Isles for measuring and inspection equipment made by Censor of Liechtenstein.

TAYLOR, TAYLOR AND HOBSON, Ltd., are to hold an exhibition of precision measuring equipment and engraving/milling machines and accessories at the Grand Hotel, Charing Cross, Glasgow, C.3, from November 17 to 22, inclusive.

PROTOLITE, Ltd., states that, as from October 27, its main office will be transferred from Central House, Upper Woburn Place, London, W.C.1, to the premises of its parent company, Murex, Ltd., Rainham, Essex (telephone, Rainham, Essex, 3322).

INTERNATIONAL HARVESTER COMPANY OF AUSTRALIA PTY., Ltd., has announced the purchase of Fowler Engineering Pty., Ltd. The new plant is to be used for the manufacture of International Harvester's construction and earth-moving equipment in Australia.

NEWTON, CHAMBERS AND CO., Ltd., Thorncliffe, near Sheffield, has made an agreement with Gottfried Bischoff, K.G., of Essen, Germany, providing for the sale, manufacture and installation within the United Kingdom and Eire, by Newton Chambers of Bischoff plant and equipment.

SYKES MACHINE TOOL COMPANY, Ltd., Staines, Middlesex, has been appointed by Schiess A.G., Düsseldorf-Oberkassel, as sole British agent for Schiess type R.F. precision gear hobbing machines, R.F.W. horizontal pinion hobbing machines and type R.S.20 vertical gear shaping machines.

CAUSEWAY REINFORCEMENT, Ltd., 66, Victoria Street, London, S.W.1, states that it has appointed William Dickinson and Co., Ltd., Proctor House, Newcastle upon Tyne, as its northern representative for "Hexmetal" armouring for roads and linings in oil refineries and all types of industrial plant.

THE AUTOMATIC TELEPHONE AND ELECTRIC COMPANY, Ltd., states that an agreement has been signed with the East African Posts and Telecommunications Administration, covering the provision of switching equipment for public telephone exchanges. The agreement embraces Kenya, Uganda and Tanganyika.

THE BRITISH ALUMINIUM COMPANY, Ltd., announces that its resident representative in Australia, Mr. E. A. Langham, is returning to the United Kingdom early in 1959; he will be succeeded by Mr. G. A. Daniels. Mr. J. W. G. Emery, the company's Malayan area representative, will become Pacific area representative on the return of Mr. Langham.

DUNLOP RUBBER COMPANY, Ltd., states that industrial wire braid hose, formerly handled by the aviation division, will in future be the responsibility of a newly-formed department at the Dunlop factory at St. George's Road, Coventry. Mr. A. J. Williams has been appointed sales manager for the general hose department, and Mr. G. R. Prosser has been appointed sales manager of the industrial wire braid department.

VICKERS-ARMSTRONGS INCORPORATED, Arlington, Virginia, U.S.A., states that it has been granted exclusive selling rights in the U.S.A. for all aviation products of Smiths Aircraft Instruments, Ltd., England, and other companies of the S. Smith and Sons (England), Ltd., group, including Kelvin and Hughes, Ltd., and Waymouth Gauges and Instruments, Ltd. Technical service is to be handled by a representative of Smiths Aircraft Instruments, Ltd., based at the Vickers-Armstrongs Incorporated premises at 399, Jefferson Davis Highway, Arlington, Virginia, U.S.A.

VICKERS, Ltd., announces that a new company, Vickers-McKay, Ltd., Vickers House, Broadway, Westminster, London, S.W.1, has been formed by the McKay Machine Company, Youngstown, Ohio, U.S.A., Vickers-Armstrongs (Engineers), Ltd., and Rockwell Machine Tool Company, Ltd., to manufacture in the United Kingdom and market throughout the world a wide range of McKay machinery. The directors of the company are Mr. R. Wonfor (chairman), Mr. W. M. Briggs, Mr. C. E. Rockwell and Mr. A. J. Wardle, Jr. The machinery will be manufactured in this country at the works of Vickers-Armstrongs (Engineers), Ltd., and sales will be carried out by Rockwell Machine Tool Company, Ltd., Welsh Harp, Edgware Road, London, N.W.2.

ELLIOTT-AUTOMATION GROUP announces that its subsidiary company, Associated Automation, Ltd., has signed agreements with the Farris Engineering Corporation, New Jersey, and the Farris Flexible Valve Corporation. A new company, Farris Engineering, Ltd., has been formed to manufacture and sell in Europe, the British Commonwealth (except Canada) and the Middle East, Farris safety-relief valves and pinch-type "Flex Valves." Mr. H. R. Walton and Mr. A. M. Reid have been appointed directors of the new company.

Contracts

THE BRITISH THOMSON-HOUSTON EXPORT COMPANY has received an order worth £2,250,000 from Fuerzas Electricas de Cataluna, of Barcelona, covering a 60MW steam turbo-alternator, boilers and all auxiliary equipment. The sub-contractor for the boilers is John Thompson Water Tube Boilers, Ltd., of Wolverhampton, and Balfour Beatty is the sub-contractor for all civil engineering design and general layout. The steam turbo-alternator will be made in one of the works of the A.E.I. Turbine-Generator Division.

GEORGE FLETCHER AND CO., of Derby, has received an order valued at nearly £300,000 from Sir J. L. Hulett and Sons, Ltd., for a cane mill tandem for a new factory at Mhlume in Swaziland. This factory is a joint venture of the Colonial Development Corporation and Sir J. L. Hulett and Sons, and will involve an extensive irrigation scheme, the conversion of a big acreage of virgin land to cane growing, and the erection of a cane sugar factory. The mill tandem consists of six three-roller cane crushing mills, 34in by 66in, complete with intercarriers, driven by six single-stage steam turbines, each developing 632 b.h.p. at full load.

Miscellanea

UNION-CASTLE LINER.—The Union-Castle Mail Steamship Company, Ltd., announces that the liner "Pendennis Castle," which has a length overall of 765ft by 83ft 6in beam and a gross tonnage of 29,000 is nearing completion at the Belfast yard of Harland and Wolff, Ltd., and will undergo trials on October 28, and will sail on her maiden voyage from Southampton on New Year's Day, 1959.

MAUDSLAY SOCIETY.—Some fifty members and guests attended the luncheon in London which preceded the annual meeting of the Maudslay Society. In proposing the toast of the society, Lord Falmouth said that the boldness and vision of the great British engineers of the past provided an example to our engineers who are now facing the challenge of industrial competition with other countries. Although countries like the U.S.A. and U.S.S.R. were producing scientists and engineers in greater numbers than Britain, we should aim at quality in training to offset this advantage in numbers, and the possibility of training more women for engineering and scientific research should be considered seriously. In responding to the toast, the president of the Society, Major J. Rennie Maudslay, stressed the importance of its work in providing financial assistance to young engineers in furthering their technical training. During the luncheon, scholarships to the value of £100 were awarded to Mr. J. I. Langford and Mr. F. J. Thomas.

FOOT SWITCHES.—Industrial heavy-duty dust- and oil-tight foot switches introduced recently by Square D, Ltd., 100, Aldersgate Street, London, E.C.1, are available in twelve different models, incorporating circuit arrangements up to two normally open and two normally closed poles. Double-throw construction is incorporated between normally open and normally closed poles to make the switches particularly useful on press control applications where the non-repeat feature is desirable. Contact operation is snap action and the trip point is adjustable with respect to the foot pedal position. Two-stage arrangements are available in several models and have a distinct "feel" between the first and second stages. Mechanically latched switches are available to provide maintained contact in either stage of two-stage models, in addition to latching on single-stage types. Latching is controlled by a small auxiliary side pedal. The switch enclosures are of cast aluminium and are gasketed to provide oil and dust-tight construction. A 1in diameter B.S. conduit entrance is provided in the rear of the switch and three mounting holes permit permanent floor or machine mounting when required. The operating pedal is deeply grooved to minimise slipping.

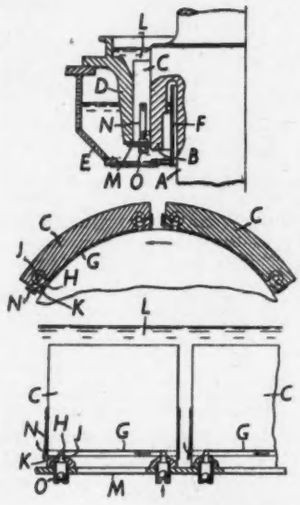
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

BEARINGS AND SUPPORTS

801,565. May 10, 1955.—PLAIN BEARINGS, The English Electric Company, Ltd., Queens House, 28, Kingsway, London, W.C.2. (*Inventor: John William Smith.*)

The invention relates to plain bearings comprising a number of circumferential pads, for example for the vertical shafts of hydraulic turbines or pumps, made self-lubricating by the viscosity drag of the rotating surface pumping lubricating oil from a sump into peripheral grooves provided in the surface of the bearing pads from where the oil is discharged in the direction of rotation at the end of each pad. According to the invention the peripheral groove in each bearing pad is in communication with the oil sump at both ends through a non-return valve opening inwardly, and to the interstitial space between adjacent bearing pads through a non-return valve opening outwardly. Depending on the direction of rotation, the non-return inlet valve at the rear end of each groove will be opened by the viscosity drag of the oil and the non-return discharge valve at the forward end will be opened by the oil pressure building up in the groove, the two other non-return valves being closed. As the drawing shows the shaft *A*



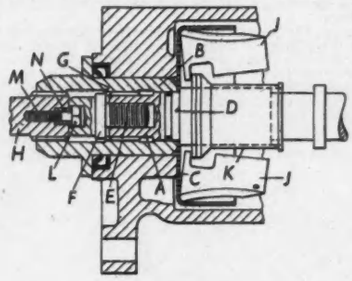
No. 801,565

has an integral collar *B* which is journalled in the pads *C* of a guide bearing *D*. These pads and the collar dip into an annular lubricating oil sump *E* which has an internal sleeve *F*. Each pad *C* has on its bearing surface near its lower edge a peripheral groove *G* which communicates through short radial bores *H* at each end with a short vertical duct *J* and with a short horizontal duct *K*. The ducts lead to the interstices between adjacent bearing pads *C* which are on top in open communication with an annular upper oil reservoir *L* surrounding the shaft *A*, and are closed at the bottom by an annular plate *M*. Leaf springs *N* are non-return valves opening outwardly from the ducts *K* towards the interstices under a pressure building up in the grooves *G* by viscosity action, as indicated in the lower views. The vertical ducts *J* lead through non-return ball valves *O* arranged in the annular plate *M* to the sump *E*. In the bottom view it is indicated that the valve *O*, which is at the rear of a pad in the sense of rotation of the arrow, is opened by the suction effect of the viscosity drag set up in the groove *G*, while the valve at the forward end is closed by the internal pressure. When the rotation of the shaft *A* is reversed, those non-return valves shown open in the lower views are automatically closed, and those shown closed are opened. This viscosity pump arrangement accordingly acts self-lubricating in both directions of rotation.—*September* 17, 1958.

SAFETY DEVICES

801,668. January 13, 1956.—SCREW LOCKING DEVICE, C.A.V., Ltd., Warple Way, Acton, London, W.3. (*Inventor: Fraser Mackie Evans.*)

For some purposes it is essential to obviate accidental slackening of a clamping screw, especially when a part of a mechanism, for example a centrifugal governor mounted on the associated spindle, is secured between the sleeve and spindle by the action of the screw. The object of the invention is to provide a simple device for reliably locking the clamping screw. In one example of a mechanism of the form above described, and required for use in a liquid fuel injection pump for an internal combustion engine as illustrated by the drawing, the rotary



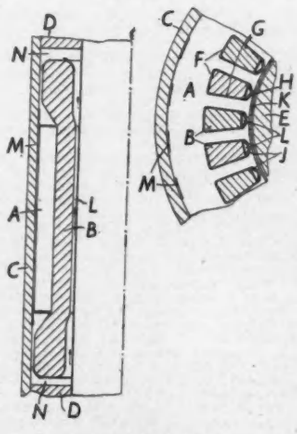
No. 801,668

actuating spindle *A* of the pump has mounted on it a centrifugal speed governor. At one end this spindle is externally splined and is engaged with one end of an internally splined sleeve *B*. A part *C* of the governor is clamped between one end of the sleeve and a shoulder *D* on the spindle, by a screw *E* in an axial hole in one end of the spindle and provided with a head *F* or washer which abuts against an internal shoulder *G* in the sleeve. The outer end of the sleeve is engaged by one end of an externally splined driving spindle *H*. In this example, the part *C* of the governor carries centrifugally operable parts *J* which by their pivotal movement can actuate a slidable sleeve *K* on the spindle *A*, the sleeve *K* serving to transmit movement from the governor to a pump output control mechanism. In one manner of securing the clamping screw *E* in accordance with the invention, the head of this screw has formed in it an axial hole of polygonal form, and this hole is occupied by a correspondingly shaped head *L* on a coupling screw *M* in an axial hole in the adjacent end of the driving spindle *H*. Preferably, and as shown, the hole in the driving spindle is counterbored to accommodate a tubular distance piece *N* through which the coupling screw *M* extends and which, when the latter is tightened with its head bearing against the adjacent end of the distance piece, affords sufficient resiliency to permit alignment of the flats on the head of the coupling screw with those of the polygonal hole in the head of the clamping screw *E*. The arrangement is such that after the clamping screw has been tightened the coupling screw is adjusted to a position in which its head can be engaged with the polygonal hole in the clamping screw when the spindle *H* is engaged with the sleeve *B*. As the spindle has no angular freedom relatively to the sleeve, the coupling screw effectively prevents accidental slackening of the clamping screw.—*September* 17, 1958.

ELECTRICAL ENGINEERING

796,970. February 28, 1956.—THE COOLING OF ELECTRIC MOTORS, Sumo Pumps, Ltd., and Louis Bertram Henry Hallett, both of Crawley, Sussex.

According to the invention, liquid-coolant circuits are provided around the stator-lamination pack and



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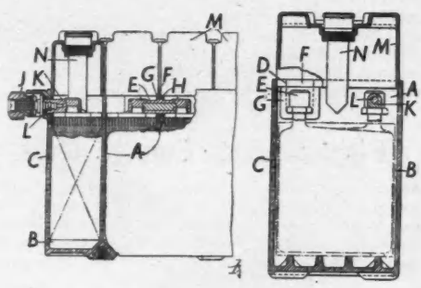
windings, passages along the inside of the stator being formed, at least in part, by hollow channel-shaped wedges in the winding slots and passages along the outside of the stator by slots in the outside of the pack. In the drawing, the stator-lamination pack is indicated at *A*, the stator winding at *B*, stator casing and end rings at *C* and *D* respectively and the rotor in outline only at *E*. The turns of the stator winding are accommodated in slots *F* lined with insulation *G* and closed by hollow or channel-shaped fibre-glass wedges *H* which are lodged in the tapering mouths *J* of the slots. A thin metal cylinder *K* lines the inside of the stator pack *A*. Longitudinal oil-circulation passages *L* at the inside of the stator are formed in the hollow wedges. If the wedges are closed on themselves on the radially inner side, as are the wedges *H*, the passages *L* are formed wholly in them. If the wedges are open on the radially inner side, the passages are formed partly in the wedges and partly in the mouths of the slots, closure on the inner side being effected by the cylinder *K*. On the outside of the stator pack *A* and inside the casing *C*, longitudinal passages *M* are provided by relatively wide shallow slots formed in the outer surface of the pack, for example by notching the laminations at their outer periphery. Beyond the ends of the pack *A*, connecting passages *N* or spaces extend around the end turns of the stator winding *B*. The slots *M* in the outside of the pack may be disposed on the same radii as the wedges *H* or, preferably and as shown in the right-hand view between the radii. In the operating position of the motor, with its axis vertical, oil ascends in the passages *L*, as it takes up heat, and descends in the slots *M*, as it gives up the heat through the casing *C*. This oil flow is indicated by arrows in the left-hand view.—*June* 25, 1958.

801,079. December 31, 1954.—ELECTRICAL STORAGE BATTERIES, Pritchett and Gold and E.P.S. Company, Ltd., Dagenham Dock, Essex. (*Inventor: Edward Spence Chapman.*)

In Patent No. 662,604 a battery is described comprising a number of separate cells the containers of which embody grooves for accommodating short straight electrically connecting bars of lead or lead alloy with means for electrical connection to the respective plate bridges and with insulating material adapted mechanically to engage and to be sealed to grooves provided in adjacent walls of adjacent cell casings. The object of the present invention is to apply certain features of this design to a battery in which the cells form part of a monobloc container. As illustrated by the drawing, each of the partitions



No. 801,079

A separating adjacent cells *B* in a monobloc electrical storage battery container *C* is provided with a U-shaped groove *D* through which a connecting bar *E* of lead or lead alloy is adapted to pass for connecting plate bridges in adjacent cells. The centre portion of each bar is embodied in a block of insulating material comprising polystyrene or other suitable plastic. This block is so shaped as to constitute a central part *F* of dimensions such as to fill the partition groove *D* and also to constitute two side plates *G* and *H* for respectively abutting the two side faces of a partition *A*. The side plates are such that the plates overlap the edges of the groove. End connection terminals *J* are provided on short bars *K* encircled by rings or panels *L* of insulating material. An inverted cup-shaped cover *M* is provided for each cell which is a press fit within the upper end of the casing *C*. Each cover is provided with a suitable detachable plug *N* which may be non-spill or approximately non-spill. When lowering a bar into position, the complementary faces on the block and partition or end wall are cemented to one another by a suitable cement, e.g. a solution of 6 per cent polystyrene in toluene in the case where polystyrene is used for composing the casing. If desired, the side faces of the partitions in the vicinity of the groove may be slightly recessed to receive the side plates *G* and *H* forming part of the block referred to above. After burning-on the connecting bars *E* to the plate bridges *O* the covers *M* of the cells are pressed into position after applying a suitable cement to the engaging surfaces.—*September* 10, 1958.

Launches and Trial Trips

FRANCOYSE DE GRACE, pilot ship; built by Chantiers Augustin Normand for the Pilots of Le Havre; length between perpendiculars 126ft 4in, breadth moulded 24ft 3½in., depth to upper deck 20ft 2½in, mean draught 10ft 10in., speed loaded 13 knots, radius of action 1750 miles; two 600 h.p. twelve-cylinder, single-acting, four-stroke diesel engines coupled to generators, two 500 h.p. electric propulsion motors. Trial, July 2.

PERREGAUX, cargo ship; built by the Ateliers et Chantiers de Bretagne for the Union Industrielle et Maritime; length between perpendiculars 277ft 3in breadth moulded 43ft 8in, depth to upper deck 25ft 7½in, deadweight 2900 tons; two S.E.M.T.-Pielstick four-stroke diesel engines, each of 1920 h.p. at 420 r.p.m. coupled to a single shaft. Trial, July 12.

KING MINOS, cargo liner; built by the Ateliers et Chantiers de France for Greek owners; length between perpendiculars 485ft 7in, breadth moulded 64ft 11½in, depth to shelter deck 41ft, deadweight 14,560 tons on 30ft 6in draught closed shelter, 12,752 tons on 27ft 2in draught open shelter; displacement 20,695 tons; trial speed 16 knots; three 200kW diesel generators; Sulzer "11.SD.72" two-stroke, single-acting diesel engine, 7700 h.p. at 125 r.p.m. Trial, July.

SAINT THIERRY, oil tanker; built by the Forges et Chantiers de la Gironde for the Compagnie Francaise d'Armement Maritime; length between perpendiculars 543ft 6in, breadth moulded 73ft 10in, depth 40ft 4in, summer draught 31ft, deadweight 20,580 tons; three 270kW, 440V, 60 c/s diesel-driven alternators; trial speed at load draught 15·7 knots; Burmeister and Wain Mark 774 VTBF 160 supercharged diesel engine built by the Forges et Ateliers du Creusot (Schneider), 8750 service h.p. at 115 r.p.m., two Foster-Wheeler boilers and one Spanner boiler. Trial, August.

CAIRNFORTH, closed shelter deck cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for the Cairn Line of Steamships, Ltd., length between perpendiculars 430ft, beam moulded 59ft 9½in; depth moulded 38ft 6in, draught 27ft 6in; 10,700 tons deadweight; five holds, steam deck machinery; three 40kW steam-driven generating sets; Hawthorn-Doxford four-cylinder, opposed-piston oil engine, 4400 b.h.p., two horizontal multi-tubular boilers. Launch, August 15.

CATANIAN, cargo ship; built by Henry Robb, Ltd., for Ellerman Lines, Ltd.; length between perpendiculars 250ft, breadth moulded 42ft 6in, depth moulded to shelter deck 23ft 6in, deadweight 1590 tons on 14ft 10in draught; electric winches, three holds; three 100kW diesel-driven generators; Clark-Sulzer seven-cylinder, two-stroke diesel engine, 2100 b.h.p. at 225 r.p.m. Trial, August 29.

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ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Sat., Oct. 18.—OXFORD AND DISTRICTS BRANCH: St. John's Hall, Marston Street, Oxford, "The Organisation of the A.S.E.E.," E. A. Bromfield, 7 p.m.

Tues., Oct. 21.—ALDERSHOT AND DISTRICTS BRANCH: Red Cross Hall, High Street, Aldershot, "What Do You Know?" 8.45 p.m. ★ LONDON NATIONAL LECTURE: Lecture Theatre, Institution of Electrical Engineers, Savoy Place, London, W.C.2, Presidential Address, Sir Josiah Eccles, 6.30 p.m. ★ STOKE AND CREWE BRANCH: Victoria Hall, Hanley, Haldane Regional Lecture, "ZETA," R. S. Pease, 7.30 p.m.

Wed., Oct. 22.—NOTTINGHAM BRANCH: Mechanic's Institution, Trinity Square, Nottingham, "Mineral Insulated Cables for Wiring and Heating," R. J. Cotton, 7.30 p.m.

Thurs., Oct. 23.—SOUTH LONDON BRANCH: Greyhound Hotel, High Street, Croydon, "Electronics in Industry," 8 p.m.

BRITISH EMPLOYERS' CONFEDERATION

To-day, Oct. 17.—Church House, Westminster, London, S.W.1, Conference on "Industrial Relations."

BRITISH INSTITUTE OF MANAGEMENT

Tues., Oct. 21.—Connaught Rooms, Holborn, W.C.2, One-Day Conference on "Computers: Top Management Appraisal."

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., Oct. 23.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Flight Evaluation of Airborne Electronic Equipment," N. G. Hinkley, 7 p.m.

Fri., Oct. 24.—SCOTTISH SECTION: Department of Natural Philosophy, The University, Edinburgh, "Flight Evaluation of Airborne Electronic Equipment," N. G. Hinkley, 7 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., Oct. 22.—MIDLAND REGION: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Dust Collecting Plant for Industrial Boilers," D. G. Hill, 10 a.m.

Thurs., Oct. 23.—SOUTHERN REGION: St. Ermins Hotel, Westminster, London, S.W.1, "Operating Problems in the Use of Solid and Liquid Fuels in the Southern Area," H. Kinsey, 10.30 a.m.; Brains Trust, "Do Training and Incentive Schemes for Boiler Operators Pay Dividends?" 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

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Tues., Oct. 21.—LIVERPOOL CENTRE: Merseyside and North Wales Electricity Board Industrial Development Centre, Liverpool, Chairman's Address, T. Jones, 6 p.m.

Mon., Oct. 27.—LEICESTER CENTRE: Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, "Shop Lighting," J. R. Just, 7 p.m.

INCORPORATED PLANT ENGINEERS

To-day, Oct. 17.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Giant Earth Mover Tyres," W. Wortley, 7.30 p.m.

Thurs., Oct. 23.—MERSEYSIDE AND NORTH WALES BRANCH: The Blossoms, Chester, "Deltic Locomotive," P. Martin, 7.15 p.m.

Mon., Oct. 27.—WEST AND EAST YORKSHIRE BRANCH: Fuel Department Lecture Theatre, New Building, The University, Leeds, "Atomic Energy," R. F. Jackson, 7.30 p.m.

Tues., Oct. 28.—SOUTH WALES BRANCH: South Wales Engineers, Institute, Park Place, Cardiff, "The Clean Air Act and Effluents," A. S. Minton, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., Oct. 21.—EAST ANGLIAN SECTION: Visit to Lake and Elliot, Ltd., Braintree, Essex, 2.15 p.m., followed by Presidential Evening. ★ SLOUGH SECTION: Lecture Theatre, High Duty Alloys, Ltd., Slough, "Modern Developments in Aluminium-Base Casting Alloys," H. J. Proffitt, 7.30 p.m.

Wed., Oct. 22.—LONDON BRANCH: Constitutional Club, Northumberland Avenue, London, W.C.2, "Solidification of Cast Iron and its Effect on Structure and Properties," H. Morrogh, 7.30 p.m.

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Tues., Oct. 28.—NORTH EAST COAST SECTION: Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne, "Petroleum Refining," E. H. Wild, 4 p.m. ★ LONDON SECTION: Memorial Building, 76, Mark Lane, London, E.C.3, "Some Recent Developments in Fiat Marine Engines," Dott. Ing. R. de Pieri, 5.30 p.m.

INSTITUTE OF NAVIGATION

Wed., Oct. 22.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Off the Beaten Track," 11.30 a.m.

INSTITUTE OF PETROLEUM

Thurs., Oct. 23.—LONDON BRANCH: 61, New Cavendish Street, London, W.1, "The Petroleum Industry in 2000 A.D.," E. S. Sellers, 6 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Oct. 27.—SCOTTISH CENTRE: North British Hotel, Princes Street, Edinburgh, "Research on the Testing and Performance of Commercial Vehicle Brakes," R. D. Lister, 7.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Mon., Oct. 20.—NORTHERN CENTRE: North-Eastern Board's Lecture Theatre, Carliol House, Newcastle upon Tyne, "Rotary Cultivation," H. Fail, 6.45 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Sat., Oct. 18.—MIDLANDS BRANCH: Technical College, Derby, "Flow Patterns in the Hydraulic Cyclone and their Interpretation in Terms of Performance," D. Bradley and D. J. Pulling, 3 p.m.

Tues., Oct. 21.—LONDON BRANCH: Geological Society, Burlington House, London, W.1, "Exploratory Study of the Flow of Granules Through Apertures," R. L. Brown and J. C. Richards, 5.30 p.m.

Tues., Oct. 28.—NORTH WESTERN BRANCH: The Blossoms Hotel, Chester, "Continuous Manufacture of Copper Sulphate," F. G. Molyneux, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 21.—Great George Street, Westminster, London, S.W.1, "The Stability of Tall Buildings," R. H. Wood, 5.30 p.m.

Fri., Oct. 24.—Great George Street, Westminster, London, S.W.1, Graduates' and Students' Conversazione, 7.30 to 11.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Oct. 17.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, Chairman's Address, R. J. Rennie, 7.30 p.m.

Sat., Oct. 18.—LONDON GRADUATE AND STUDENT SECTION: Visit to Metropolitan Water Board, Ashford Common, Staines, 2.30 p.m.

Mon., Oct. 20.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "The Presentation of Electrical Science in Schools," opened by G. R. Noakes, 6 p.m. ★ EAST ANGLIAN SUB-CENTRE: Crown and Anchor Hotel, Ipswich, "High-Quality Sound Reproduction," J. Moir, 6.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Royal Institution, Colquitt Street, Liverpool, Discussion on "Electronic Control of Machine Tools," opened by D. T. N. Williamson, 6.30 p.m. ★ NORTH-EASTERN RADIO AND MEASUREMENT GROUP: King's College, Newcastle upon Tyne, Chairman's Address, G. H. Hickling, 6.15 p.m. ★ SHEFFIELD SUB-CENTRE: Angel Hotel, Brigg, Repeat of Chairman's Address, F. A. Benson, 6.45 p.m. ★ WESTERN SUPPLY GROUP: S.W.E.B. Demonstration Theatre, Electricity House, Colston Avenue, Bristol, 1, Chairman's Address, A. G. Milne, 6 p.m.

Tues., Oct. 21.—E. MIDLAND CENTRE: College of Arts and Crafts, Waverley Street, Nottingham, "The Design of the 330kV Transmission System for Rhodesia," F. C. Winfield, T. W. Wilcox and G. Lyon, 6.30 p.m. ★ N. MIDLAND UTILIZATION GROUP: 1, Whitehall Road, Leeds, "Electric Control of Stage and Television Lighting," F. P. Bentham, 6 p.m. ★ N.W. SUPPLY GROUP: Engineers' Club, Albert Square, Manchester, "The Design and Performance of the Gas-Filled Cable System," E. P. G. Thornton and D. H. Booth, 6.15 p.m. ★ S. MIDLAND CENTRE: College of Technology, Gosta Green, Birmingham, Discussion on "Electric Traction," opened by J. A. Broughall, 6.15 p.m.

Wed., Oct. 22.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Random Thoughts of a Propagation Engineer," G. Millington, 5.30 p.m. ★ SOUTHERN CENTRE: Technical College, Brighton, "Operational Experience at Calder Hall," K. L. Stretch, 6.30 p.m.

Mon., Oct. 27.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Rating of Speech Links and Performance of Telephone Networks," J. Swaffield and D. L. Richards; "Assessment of Speech Communication Links," D. L. Richards and J. Swaffield, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Oct. 17.—ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, Presidential Address, "The Mechanical Engineering of Aircraft Mechanisms," Air Marshal Sir Owen Jones, 6 p.m.

Mon., Oct. 20.—DERBY A.D. CENTRE: Railway College, London Road, Derby, "Basis of Railway Signalling," G. Holt, 7.15 p.m. ★ SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Chairman's Address, 7.30 p.m. ★ N.W. BRANCH LIVERPOOL PANEL: Royal Institution, Colquitt Street, Liverpool, "The Electronic Control of Machine Tools," 6.30 p.m. ★ MIDLAND GRADUATE SECTION: Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Development of High Temperature Nuclear Reactors and Medium Size Nuclear Power Plants," G. B. R. Feilden, 7 p.m.

Tues., Oct. 21.—S. WALES BRANCH: S. Wales Institute of Engineers, Cardiff, "Inspection of Vehicles for Roadworthiness," G. Grime and R. D. Lister, 6 p.m. ★ E. GRADUATES' SECTION: College of Further Education, Park Square, Luton, "Artificial Satellites," E. M. Dowlen, 7.30 p.m. ★ LONDON GRADUATE SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "New High Altitude Test Plant under Construction at the National Gas Turbine Establishment," F. R. Umpleby, 6.30 p.m. ★ SOUTHERN GRADUATE SECTION: Technical College, Reading, "Electronics for Mechanical Engineers," R. G. Davis, 7.30 p.m.

Wed., Oct. 22.—EDUCATION GROUP DISCUSSION: 1, Birdcage Walk, Westminster, London, S.W.1, "Recent Developments in Engineering Education in the United States of America," 6 p.m. ★ E. MIDLANDS BRANCH: Royal Hotel, Grimsby, "Recent Developments in Propulsion Machinery and Refrigeration Equipment for Deep Sea Trawlers," G. C. Eddie, 7.30 p.m. ★ YORKSHIRE BRANCH: Grand Hotel, Sheffield, "Management Control of Small Engineering Firms," L. Fontaine, W. R. Spencer and J. W. Walker, 6.30 p.m.

Thurs., Oct. 23.—E. BRANCH: Hoffman Hall, Chelmsford, "Clean Rooms for the Assembly of Electrical and Mechanical Instruments," H. G. Harris, 7.30 p.m. ★ N.E. BRANCH: Stephenson Building, Claremont Road, Newcastle upon Tyne, "Theoretical Analysis of the Stresses Induced in a Spherical Pressure Vessel due to Constraining Effect of a Cylindrical Skirt," R. Hicks, 6.30 p.m. ★ N.W. BRANCH, INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: Engineers' Club, Albert Square, Manchester, "Development of Sintered Oxide Tools," R. N. Cook, 6.45 p.m. ★ YORKSHIRE BRANCH: The University, Leeds, "Management Control of Small Engineering Firms," L. Fontaine, W. R. Spencer and J. W. Walker, 6.30 p.m. ★ E. MIDLANDS GRADUATE SECTION: Gas Showrooms, Church Street, Peterborough, "Power from Nuclear Energy," M. D. Wood, 7.15 p.m.

Fri., Oct. 24.—1, Birdcage Walk, Westminster, London, S.W.1, Symposium on Engine Noise and Noise Suppression, arranged by the Internal Combustion Engine Group Committee, 4 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Oct. 17.—IPSWICH AND COLCHESTER SECTION: Britannia Works Canteen, Davey, Paxman and Co., Ltd., Colchester, "Building Merchant Ships in a Modern Shipyard," J. Leather, 7.30 p.m.

Mon., Oct. 20.—COVENTRY SECTION: Craven Arms, High Street, Coventry, "Automatically Controlled Machine Tools," J. A. Stokes, 7.15 p.m. ★ DERBY SECTION: Louis Room, St. James Restaurant, St. James Street, Derby, "Lens—Their Manufacture and Uses," E. Atkinson, 7 p.m.

Wed., Oct. 22.—NORWICH SECTION: Assembly House, Norwich, "Die Casting—How Would You Make It?" A. R. L. Chivers, film, 7.30 p.m. ★ LUTON GRADUATE SECTION: Town Hall, Luton, "Plastics—Materials and Methods," H. H. Starte, 7.30 p.m.

Thurs., Oct. 23.—LINCOLN SECTION: Ruston Club, Lincoln, "Plastics Materials in Engineering," A. Clark, 7.30 p.m. ★ LONDON SECTION: Royal Empire Society, Northumberland Avenue, London, W.C.2, "Alloy Steels" (History, Manufacture and Applications), R. E. Linton, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Oct. 17.—WESTERN COUNTIES BRANCH: University Engineering Laboratories, Bristol, Chairman's Address, "Modular Co-ordination in Building," P. Gardiner, 6 p.m.

Tues., Oct. 21.—NORTHERN COUNTIES BRANCH: Cleveland Scientific and Technical Institution, Middlesbrough, Chairman's Address, D. W. Portus, 6.30 p.m.

Thurs., Oct. 23.—11, Upper Belgrave Street, London, S.W.1, "Aluminium and Tubular Steel as Applied to the Construction of Some Recent Aircraft Hangars," L. E. Ward, 6 p.m.

Fri., Oct. 24.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, B. C. Britton, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 17.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Radio Measurements on the Russian Earth Satellites," J. Heywood, 7 p.m.

Fri., Oct. 24.—INFORMAL MEETING: Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Progress in Fluid Couplings," J. W. Lee, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Mon., Oct. 20.—Literary and Philosophical Society, Newcastle upon Tyne, Presidential Address, E. J. Hunter, 6.15 p.m.

PLASTICS INSTITUTE

To-day, Oct. 17.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Polypropylene," F. Ranalli and G. Crespi, 6.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 22.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, "Cavitation Damage," D. J. Godfrey, 6.30 p.m.

SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., Oct. 20.—The University Building, St. George's Square, Sheffield, "Atmospheric Pollution in the Iron and Steel Industry," J. H. Flux and F. A. Gray, 7.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Mon., Oct. 20.—DATA PROCESSING SECTION: Manson House, Portland Place, London, W.1, "A Simple Data Read-Out System," G. D. Tonkin, 6 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, Oct. 17.—39, Elmbank Crescent, Glasgow, Presidential Address, H. Harris, 6.45 p.m.

Launches and Trial Trips

FRANCOYSE DE GRACE, pilot ship; built by Chantiers Augustin Normand for the Pilots of Le Havre; length between perpendiculars 126ft 4in, breadth moulded 24ft 3½in., depth to upper deck 20ft 2½in, mean draught 10ft 10in., speed loaded 13 knots, radius of action 1750 miles; two 600 h.p. twelve-cylinder, single-acting, four-stroke diesel engines coupled to generators, two 500 h.p. electric propulsion motors. Trial, July 2.

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Wed., Oct. 22.—MERSEYSIDE AND NORTH WESTERN SECTION: Central College of Further Education, Barrow-in-Furness, "Diesel Hydraulic Propulsion," F. J. Mayor, 2.15 p.m. ★ SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Notes for the Junior Engineer on the Operation of Marine Machinery," R. M. Dunshea, 7.30 p.m. ★ SOUTH WALES SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "Conversion of the 'Ocean Layer,'" M. R. L. Hayes, 7 p.m.

Thurs., Oct. 23.—KINGSTON UPON HULL AND EAST MIDLANDS SECTION: Royal Station Hotel, Kingston upon Hull, "Gas Turbines for Industrial and Marine Applications," W. C. Vickers, 7.30 p.m. ★ INFORMAL MEETING: Memorial Building, 76, Mark Lane, London, E.C.3, Discussion on "Deck and Engine Auxiliaries," introduced by D. W. Malim, 5.30 p.m.

Tues., Oct. 28.—NORTH EAST COAST SECTION: Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne, "Petroleum Refining," E. H. Wild, 4 p.m. ★ LONDON SECTION: Memorial Building, 76, Mark Lane, London, E.C.3, "Some Recent Developments in Fiat Marine Engines," Dott. Ing. R. de Pieri, 5.30 p.m.

INSTITUTE OF NAVIGATION

Wed., Oct. 22.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Off the Beaten Track," 11.30 a.m.

INSTITUTE OF PETROLEUM

Thurs., Oct. 23.—LONDON BRANCH: 61, New Cavendish Street, London, W.1, "The Petroleum Industry in 2000 A.D.," E. S. Sellers, 6 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Oct. 27.—SCOTTISH CENTRE: North British Hotel, Princes Street, Edinburgh, "Research on the Testing and Performance of Commercial Vehicle Brakes," R. D. Lister, 7.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Mon., Oct. 20.—NORTHERN CENTRE: North-Eastern Board's Lecture Theatre, Carliol House, Newcastle upon Tyne, "Rotary Cultivation," H. Fail, 6.45 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Sat., Oct. 18.—MIDLANDS BRANCH: Technical College, Derby, "Flow Patterns in the Hydraulic Cyclone and their Interpretation in Terms of Performance," D. Bradley and D. J. Pulling, 3 p.m.

Tues., Oct. 21.—LONDON BRANCH: Geological Society, Burlington House, London, W.1, "Exploratory Study of the Flow of Granules Through Apertures," R. L. Brown and J. C. Richards, 5.30 p.m.

Tues., Oct. 28.—NORTH WESTERN BRANCH: The Blossoms Hotel, Chester, "Continuous Manufacture of Copper Sulphate," F. G. Molyneux, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 21.—Great George Street, Westminster, London, S.W.1, "The Stability of Tall Buildings," R. H. Wood, 5.30 p.m.

Fri., Oct. 24.—Great George Street, Westminster, London, S.W.1, Graduates' and Students' Conversazione, 7.30 to 11.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Oct. 17.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, Chairman's Address, R. J. Rennie, 7.30 p.m.

Sat., Oct. 18.—LONDON GRADUATE AND STUDENT SECTION: Visit to Metropolitan Water Board, Ashford Common, Staines, 2.30 p.m.

Mon., Oct. 20.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "The Presentation of Electrical Science in Schools," opened by G. R. Noakes, 6 p.m. ★ EAST ANGLIAN SUB-CENTRE: Crown and Anchor Hotel, Ipswich, "High-Quality Sound Reproduction," J. Moir, 6.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Royal Institution, Colquitt Street, Liverpool, Discussion on "Electronic Control of Machine Tools," opened by D. T. N. Williamson, 6.30 p.m. ★ NORTH-EASTERN RADIO AND MEASUREMENT GROUP: King's College, Newcastle upon Tyne, Chairman's Address, G. H. Hickling, 6.15 p.m. ★ SHEFFIELD SUB-CENTRE: Angel Hotel, Brigg, Repeat of Chairman's Address, F. A. Benson, 6.45 p.m. ★ WESTERN SUPPLY GROUP: S.W.E.B. Demonstration Theatre, Electricity House, Colston Avenue, Bristol, 1, Chairman's Address, A. G. Milne, 6 p.m.

Tues., Oct. 21.—E. MIDLAND CENTRE: College of Arts and Crafts, Waverley Street, Nottingham, "The Design of the 330kV Transmission System for Rhodesia," F. C. Winfield, T. W. Wilcox and G. Lyon, 6.30 p.m. ★ N. MIDLAND UTILIZATION GROUP: 1, Whitehall Road, Leeds, "Electric Control of Stage and Television Lighting," F. P. Bentham, 6 p.m. ★ N.W. SUPPLY GROUP: Engineers' Club, Albert Square, Manchester, "The Design and Performance of the Gas-Filled Cable System," E. P. G. Thornton and D. H. Booth, 6.15 p.m. ★ S. MIDLAND CENTRE: College of Technology, Gosta Green, Birmingham, Discussion on "Electric Traction," opened by J. A. Broughall, 6.15 p.m.

Wed., Oct. 22.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Random Thoughts of a Propagation Engineer," G. Millington, 5.30 p.m. ★ SOUTH MIDLAND CENTRE: Technical College, Brighton, "Operational Experience at Calder Hall," K. L. Stretch, 6.30 p.m.

Mon., Oct. 27.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Rating of Speech Links and Performance of Telephone Networks," J. Swaffield and D. L. Richards; "Assessment of Speech Communication Links," D. L. Richards and J. Swaffield, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Oct. 17.—ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, Presidential Address, "The Mechanical Engineering of Aircraft Mechanisms," Air Marshal Sir Owen Jones, 6 p.m.

Mon., Oct. 20.—DERBY A.D. CENTRE: Railway College, London Road, Derby, "Basis of Railway Signalling," G. Holt, 7.15 p.m. ★ SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Chairman's Address, 7.30 p.m. ★ N.W. BRANCH LIVERPOOL PANEL: Royal Institution, Colquitt Street, Liverpool, "The Electronic Control of Machine Tools," 6.30 p.m. ★ MIDLAND GRADUATE SECTION: Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Development of High Temperature Nuclear Reactors and Medium Size Nuclear Power Plants," G. B. R. Feilden, 7 p.m.

Tues., Oct. 21.—S. WALES BRANCH: S. Wales Institution of Engineers, Cardiff, "Inspection of Vehicles for Roadworthiness," G. Grime and R. D. Lister, 6 p.m. ★ E. GRADUATE SECTION: College of Further Education, Park Square, Leeds, "Artificial Satellites," E. M. Dowlen, 7.30 p.m. ★ LONDON GRADUATE SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "New High Altitude Test Plant under Construction at the National Gas Turbine Establishment," F. R. Umpleby, 6.30 p.m. ★ SOUTHERN GRADUATE SECTION: Technical College, Reading, "Electronics for Mechanical Engineers," R. G. Davis, 7.30 p.m.

Wed., Oct. 22.—EDUCATION GROUP DISCUSSION: 1, Birdcage Walk, Westminster, London, S.W.1, "Recent Developments in Engineering Education in the United States of America," 6 p.m. ★ E. MIDLANDS BRANCH: Royal Hotel, Grimsby, "Recent Developments in Propulsion Machinery and Refrigeration Equipment for Deep Sea Trawlers," G. C. Edgell, 7.30 p.m. ★ YORKSHIRE BRANCH: Grand Hotel, Sheffield, "Management Control of Small Engineering Firms," L. Fontaine, W. R. Spencer and J. W. Walker, 6.30 p.m.

Thurs., Oct. 23.—E. BRANCH: Hoffman Hall, Chelmsford, "Clean Rooms for the Assembly of Electrical and Mechanical Instruments," H. G. Harris, 7.30 p.m. ★ N.E. BRANCH: Stephenson Building, Claremont Road, Newcastle upon Tyne, "Theoretical Analysis of the Stresses Induced in a Spherical Pressure Vessel due to Constraining Effect of a Cylindrical Skirt," R. Hicks, 6.30 p.m. ★ N.W. BRANCH, NORTHERN ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: Engineers' Club, Albert Square, Manchester, "Development of Sintered Oxide Tools," R. N. Cook, 6.45 p.m. ★ YORKSHIRE BRANCH: The University, Leeds, "Management Control of Small Engineering Firms," L. Fontaine, W. R. Spencer and J. W. Walker, 6.30 p.m. ★ E. MIDLANDS GRADUATE SECTION: Gas Showrooms, Church Street, Peterborough, "Power from Nuclear Energy," M. D. Wood, 7.15 p.m.

Fri., Oct. 24.—1, Birdcage Walk, Westminster, London, S.W.1, Symposium on Engine Noise and Noise Suppression, arranged by the Internal Combustion Engine Group Committee, 4 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Oct. 17.—IPSWICH AND COLCHESTER SECTION: Britannia Works Canteen, Davey, Paxman and Co., Ltd., Colchester, "Building Merchant Ships in a Modern Shipyard," J. Lamb, 7.30 p.m.

Mon., Oct. 20.—COVENTRY SECTION: Craven Arms, High Street, Coventry, "Automatically Controlled Machine Tools," J. A. Stokes, 7.15 p.m. ★ DERBY SECTION: Louis Room, St. James Restaurant, St. James Street, Derby, "Lens—Their Manufacture and Uses," E. Atkinson, 7 p.m.

Wed., Oct. 22.—NORWICH SECTION: Assembly House, Norwich, "Die Casting—How Would You Make It?" A. R. L. Clarke, film, 7.30 p.m. ★ LUTON GRADUATE SECTION: Town Hall, Luton, "Plastics—Materials and Methods," R. H. Stone, 7.30 p.m.

Thurs., Oct. 23.—LINCOLN SECTION: Ruston Club, Lincoln, "Plastics Materials in Engineering," A. Clark, 7.30 p.m. ★ LONDON SECTION: Royal Empire Society, Northumberland Avenue, London, W.C.2, "Alloy Steels" (History, Manufacture and Applications), R. E. Linton, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Oct. 17.—WESTERN COUNTIES BRANCH: Unwin Engineering Laboratories, Bristol, Chairman's Address, "Modular Co-ordination in Building," P. Gardiner, 6 p.m.

Tues., Oct. 21.—NORTHERN COUNTIES BRANCH: Cleveland Scientific and Technical Institution, Middlesbrough, Chairman's Address, D. W. Portus, 6.30 p.m.

Thurs., Oct. 23.—11, Upper Belgrave Street, London, S.W.1, "Aluminium and Tubular Steel as Applied to the Construction of Some Recent Aircraft Hangars," L. E. Ward, 6 p.m.

Fri., Oct. 24.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, B. C. Britton, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 17.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Radio Measurements on the Russian Satellites," J. Heywood, 7 p.m.

Fri., Oct. 24.—INFORMAL MEETING: Pepys House, 14 Rochester Row, Westminster, London, S.W.1, "Progress in Fluid Couplings," J. W. Lee, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Mon., Oct. 20.—Literary and Philosophical Society, Newcastle upon Tyne, Presidential Address, E. J. Hunter, 6.15 p.m.

PLASTICS INSTITUTE

To-day, Oct. 17.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Polypropylene," F. Ranalli and G. Crespi, 6.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 22.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, "Cavitation Damage," D. J. Garland, 6.30 p.m.

SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., Oct. 20.—The University Building, St. George's Square, Sheffield, "Atmospheric Pollution in the Iron and Steel Industry," J. H. Flux and F. A. Gray, 7.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Mon., Oct. 20.—DATA PROCESSING SECTION: Manson House, Portland Place, London, W.1, "A Simple Data Recording System," G. D. Tonkin, 6 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, Oct. 17.—39, Elmbank Crescent, Glasgow, Presidential Address, H. Harris, 6.45 p.m.

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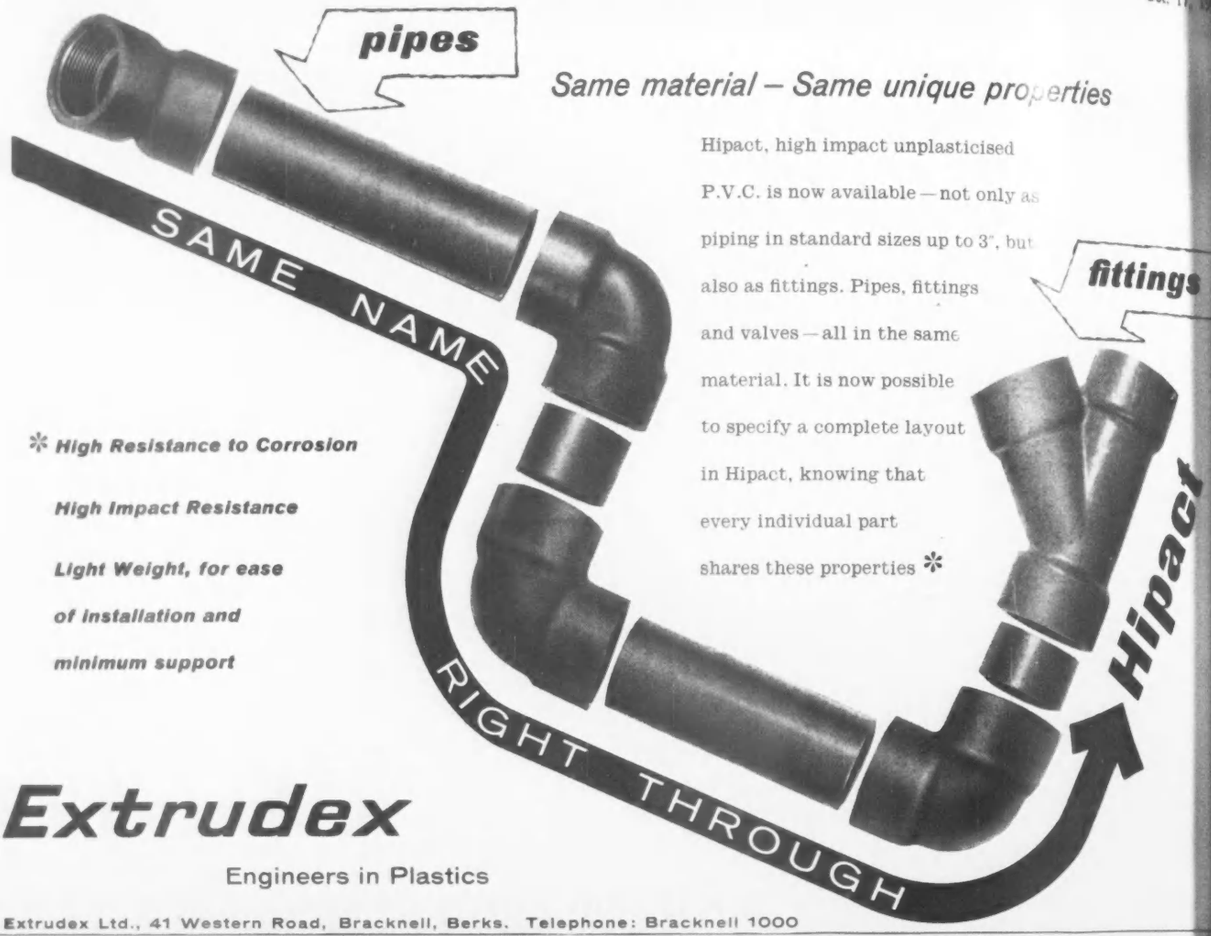

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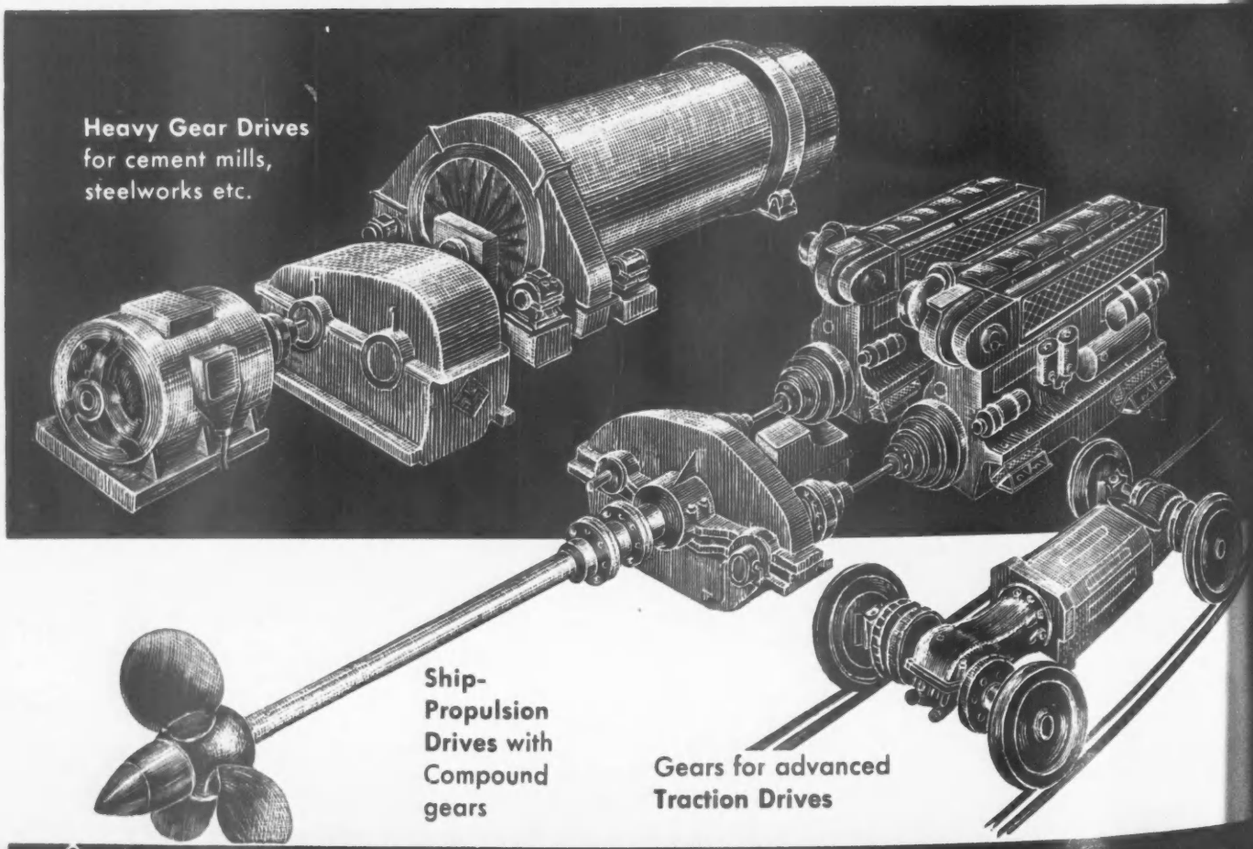

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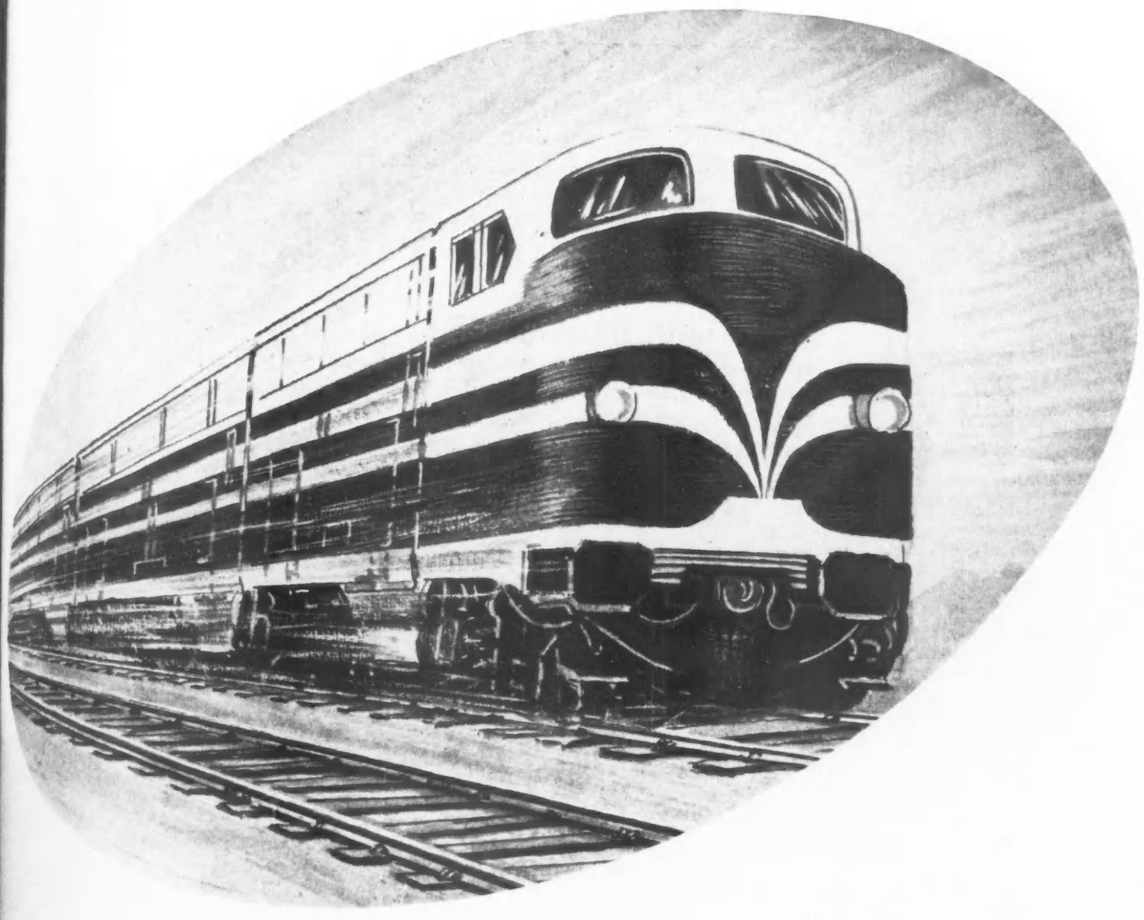

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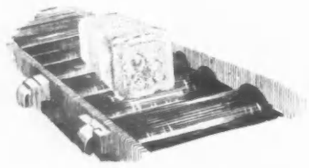

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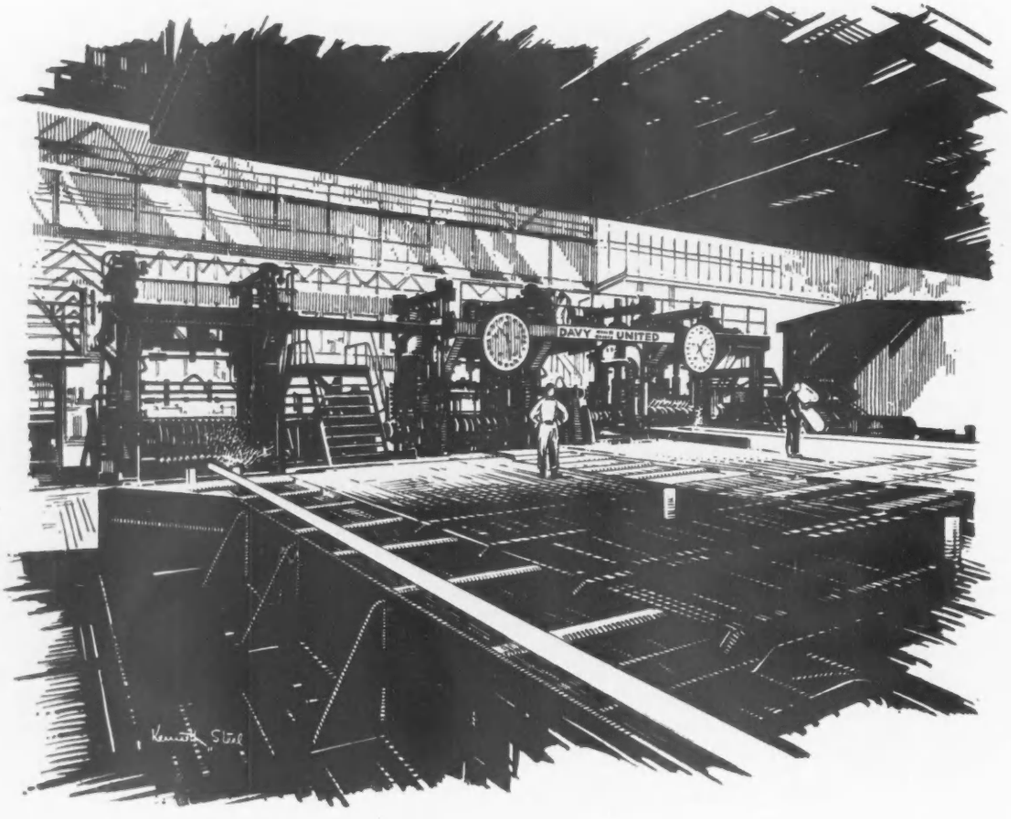

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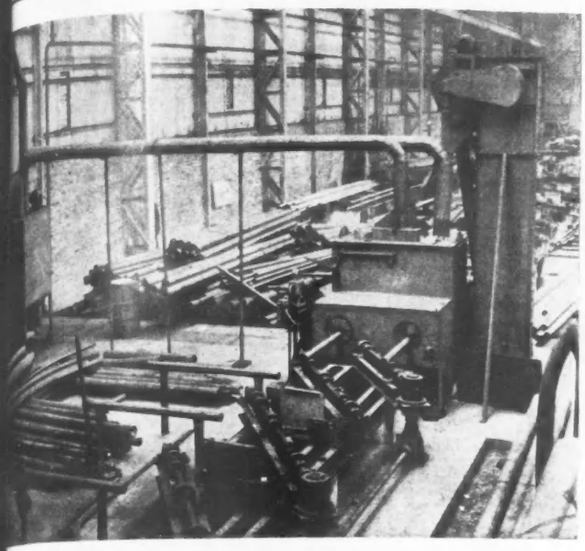

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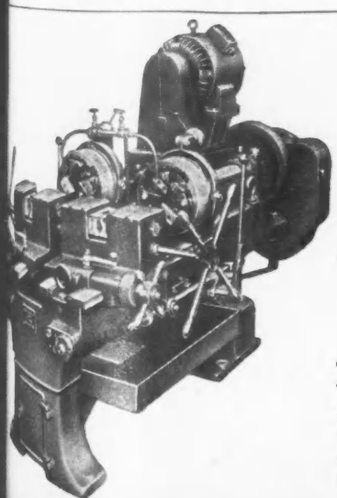

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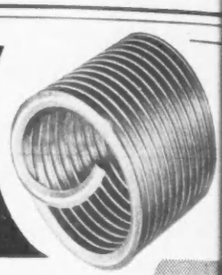

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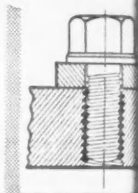

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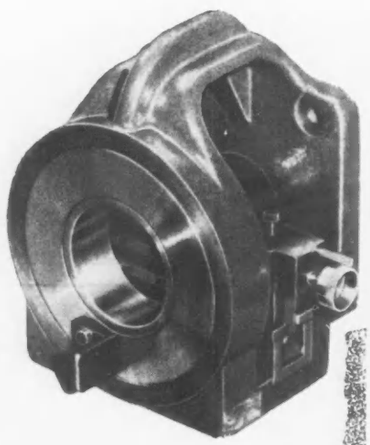

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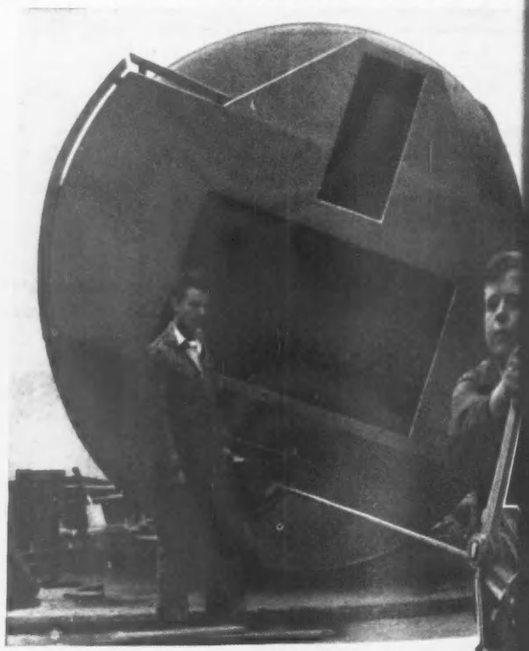

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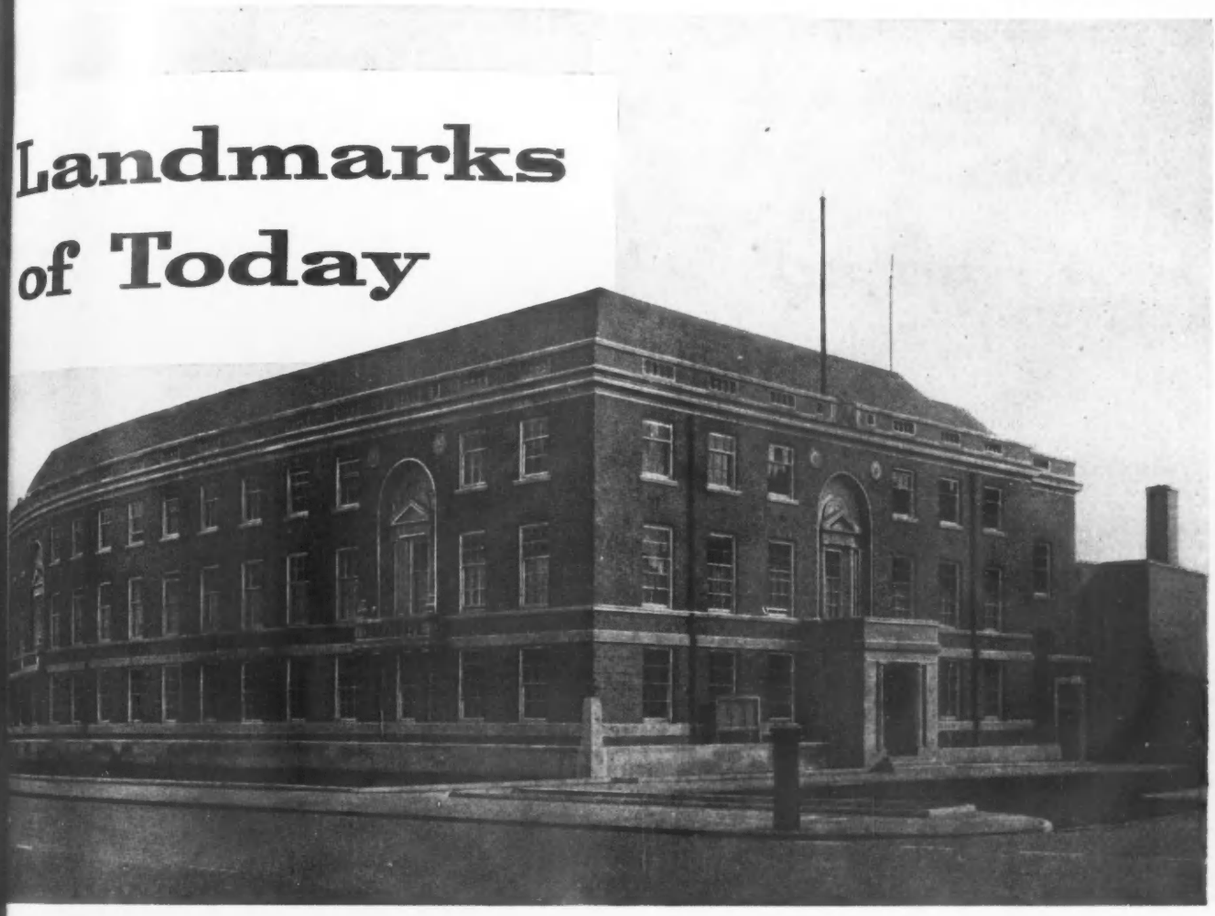

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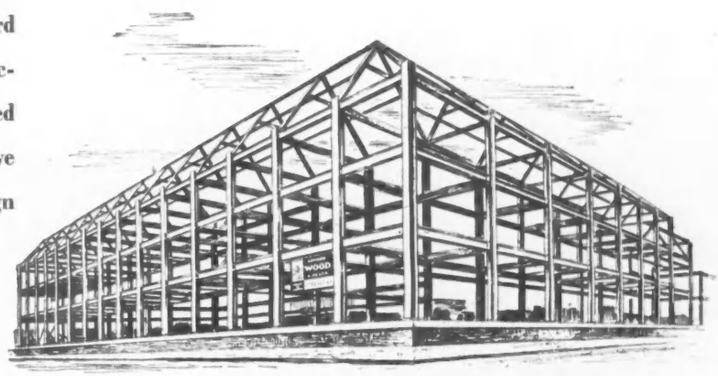

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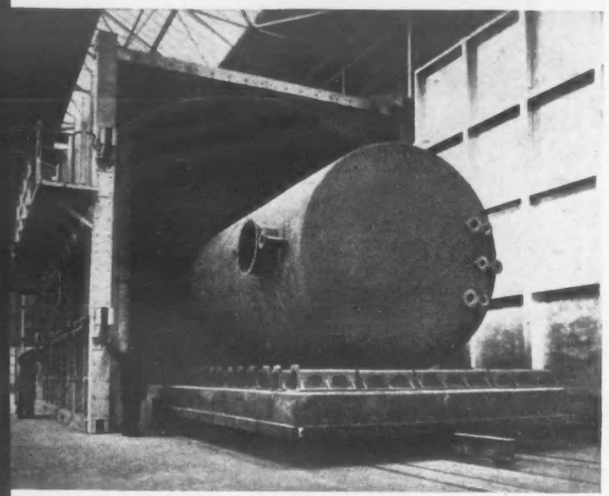
K

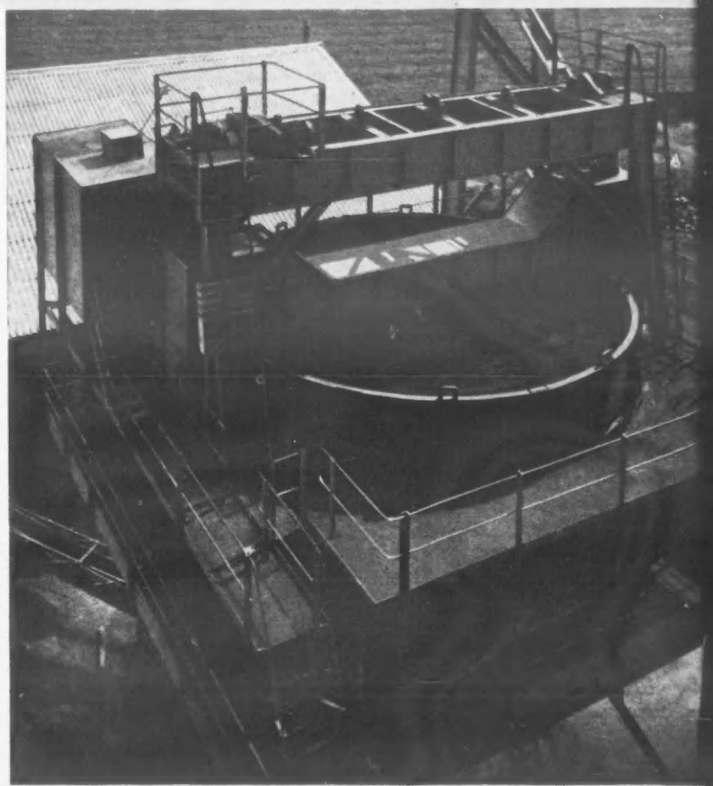
NEWTON CHAMBERS



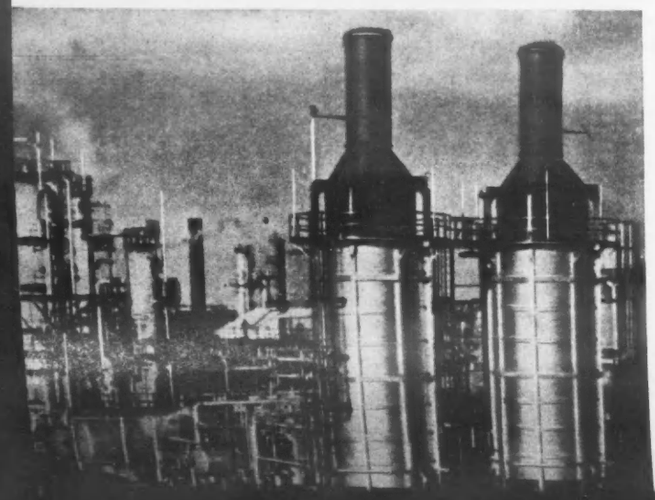
FOR MANY YEARS Newton Chambers have specialised in the design, fabrication and assembly of plant and equipment for the basic and heavy industries. This past year has seen many new developments and extension of production facilities. In addition to developments through our own research department we have made several important agreements with American and Continental organisations to manufacture the most up-to-date plant and equipment of their respective types in this country.

To deal with the increased scope the constructional shops at Thorncliffe have been extended and equipped to include facilities for welding to class 1 standards, stress relieving and X-ray examination. Today Newton Chambers are better equipped than ever before to provide a comprehensive service to industry.

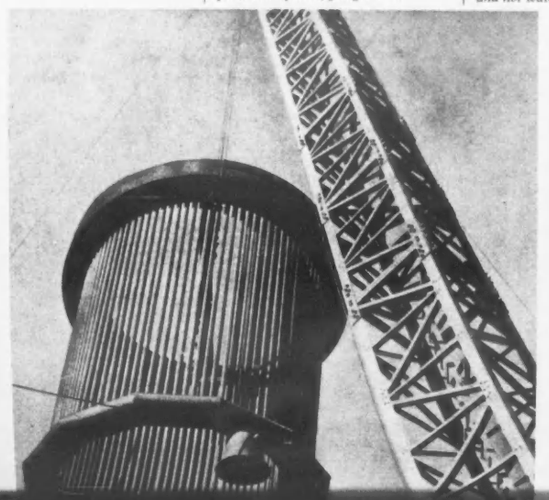
This stress relieving furnace included in the new facilities provided at Thorncliffe for welding to class 1 standards, takes vessels up to 15 ft. in diameter, up to 100 ft. in length and up to 70 tons in weight.



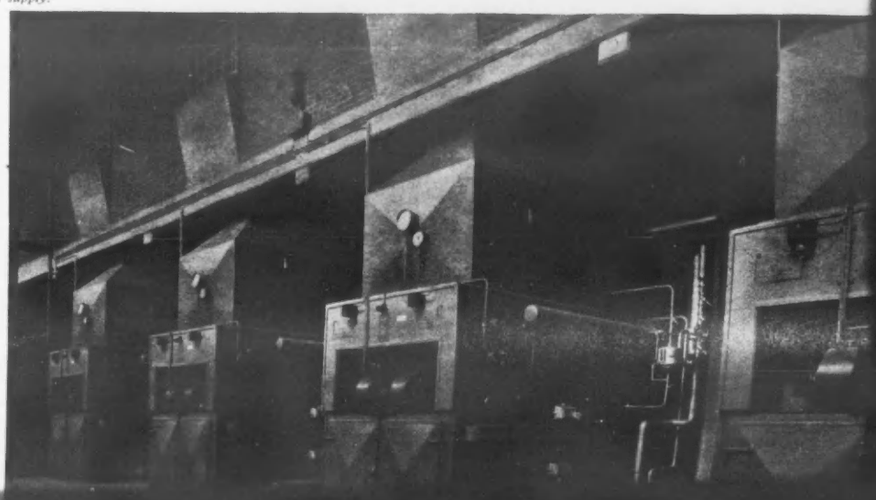
Newton Chambers continue to lead in the design of plant for the gas industry particularly with the mechanisation of tower purifiers. The new patented mechanical oxide discharger shown here is economical in operation, reduces labour requirements and is clean in action.



BELOW LEFT *Newton Chambers can offer direct to British industry the well-known Struthers Wells equipment for industrial heating at elevated temperatures.*

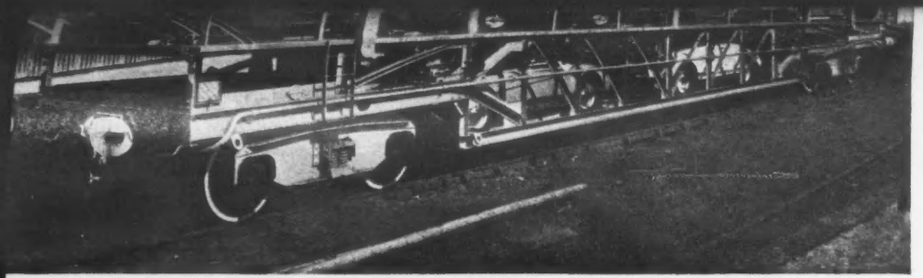


BELOW *The new radiant type Inka Preheater manufactured under licence from Industrikemiska extends our heat exchange equipment to deal with temperatures up to 875 degrees C.*



BELOW RIGHT *Redfyre Emma Coke Boilers are now manufactured at Thorncliffe to provide this country with the highest efficiency in central heating and hot water supply.*

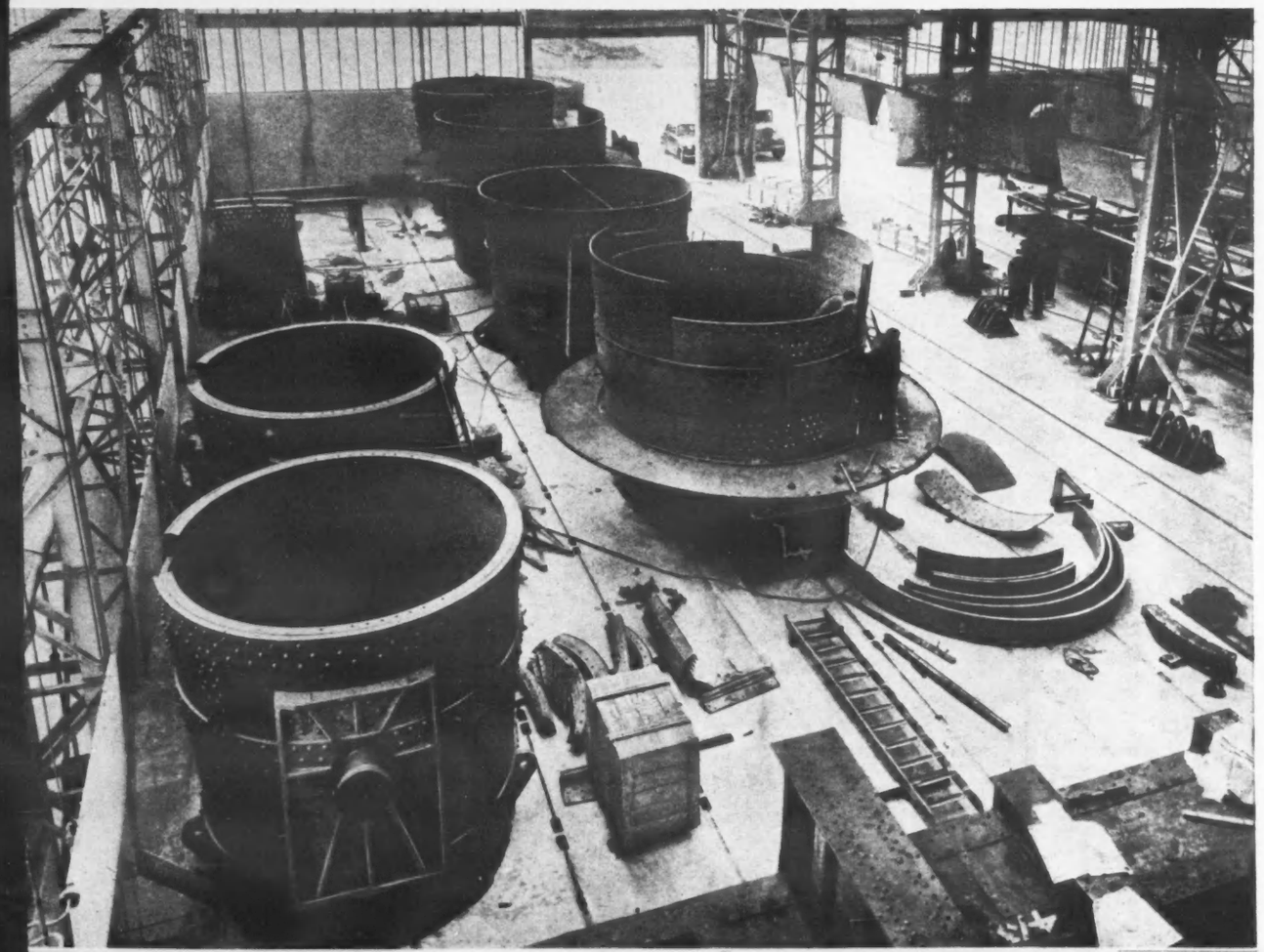
Newton

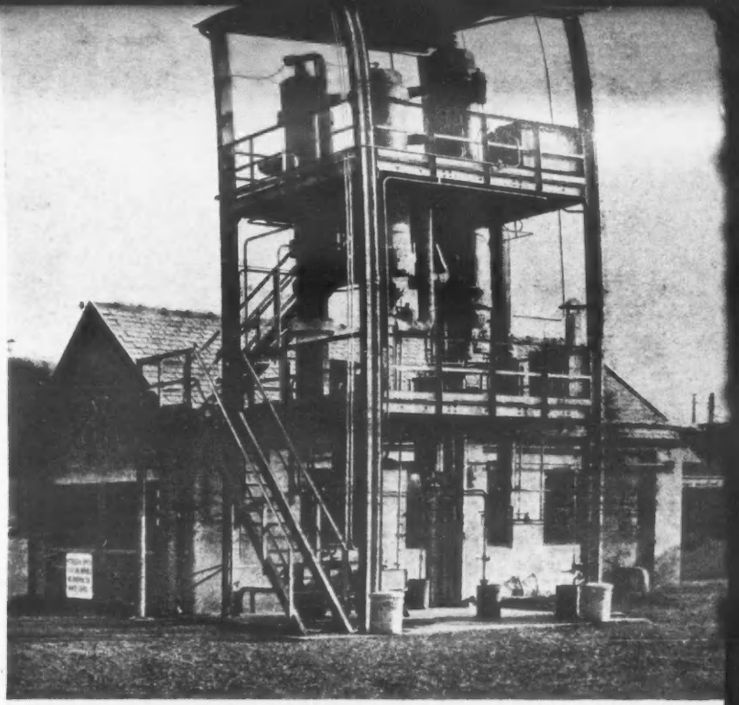


Newton Chambers

An outstanding result of research in collaboration with the Coal Tar Research Association is the new plant for the hydro-refining of Benzoles and Naphthas.

Further extensions to the constructional shops at Thorncliffe increase capacity for manufacturing larger industrial plant such as the 275 ton capacity ladles for the steel industry shown here.





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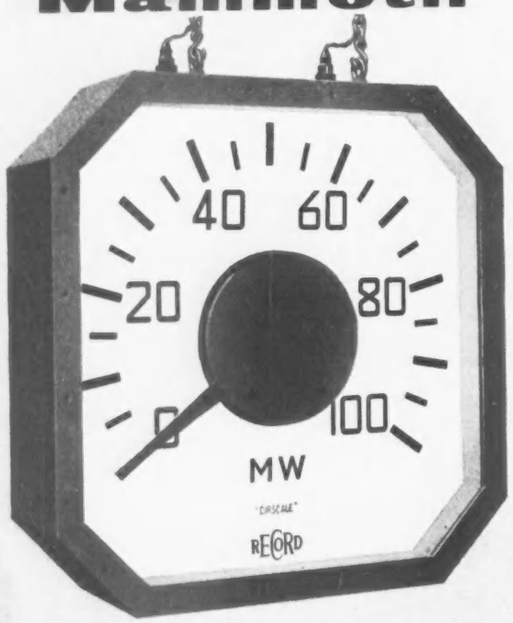

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With a scale length of 5 feet, bold figures and internal illumination, this instrument can be read accurately at considerable distances. It complies fully with BSS 89/1954 and combines ample power with high sensitivity. It is suitable for indicating Amps, Milliamps, Volts, R.P.M. or Frequency, or any value which may be converted into one of these. Single or double sided models available

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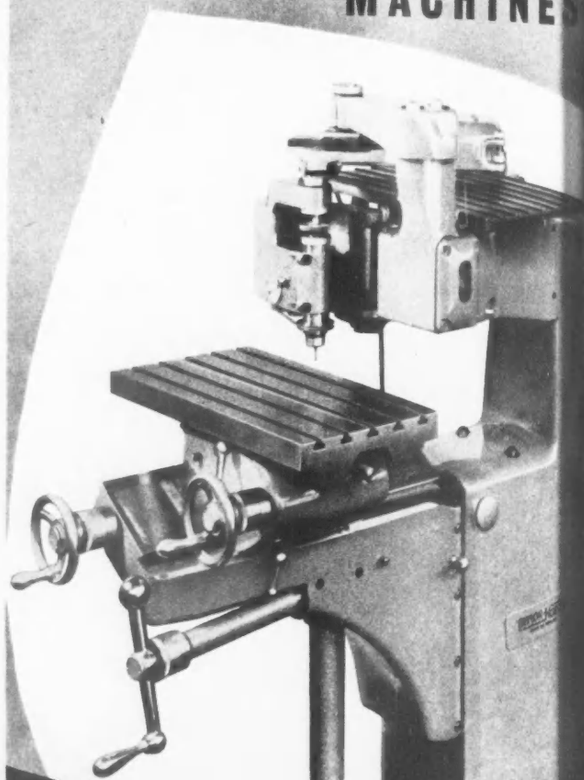

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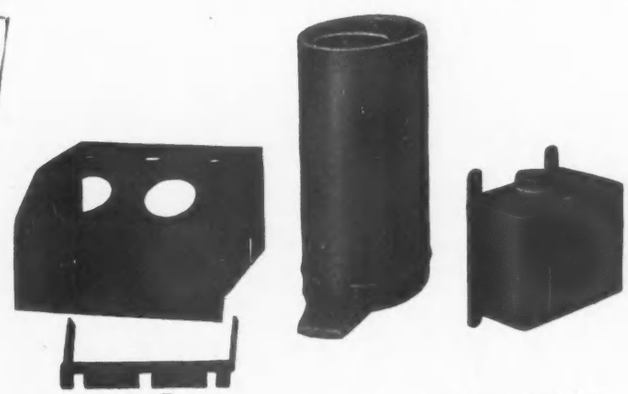
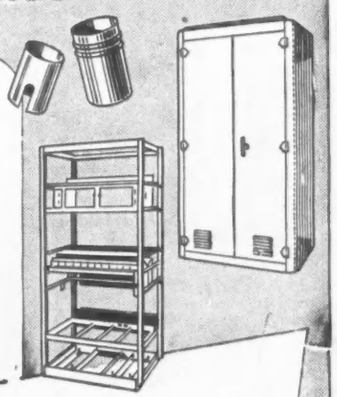
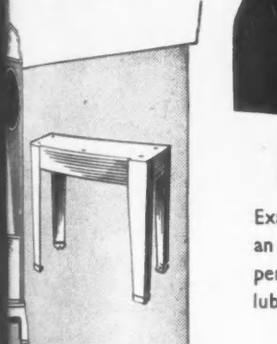


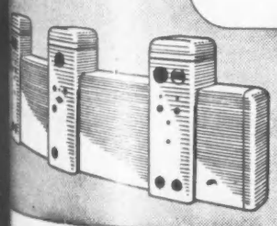
Examples of general sheet metal work shown here comprise an Air Compressor Control Panel, a High Pressure Grease Dispenser, and on the right, an Oil Tank used for the automatic lubrication of commercial vehicles.

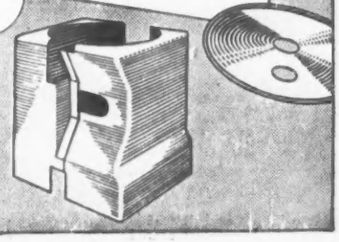
Contractors to Admiralty, Ministry of Supply and G.P.O.



Well-equipped tool-room for the manufacture of the necessary tools to your designs or our own.







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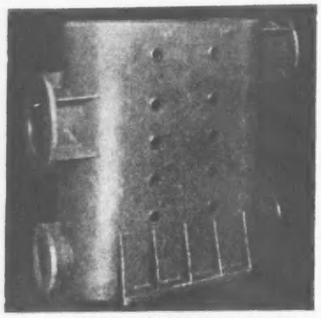

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PROPRIETORS

EVEN IF THEY HAVE TO BE SPECIALLY MADE

We've always said that Unbrako screws cost less than trouble.

But it happens that once in a while a customer needs a screw that cannot be found even in the vast Unbrako range.

So we make them to the customer's own specification, or design specially for him.

And even when we have to make specially, Unbrako still costs less than trouble.

So, rest assured, standard or not, you can always safely specify Unbrako screws and make sure of getting the finest fasteners that are made anywhere in the world. Details of sizes and threads will gladly be sent on request.

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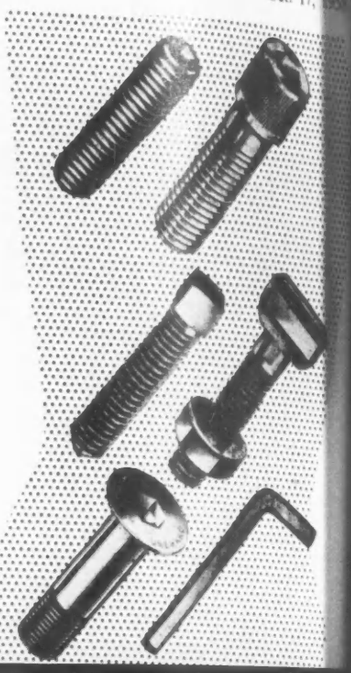

UNBRAKO SCREWS still COST LESS THAN TROUBLE

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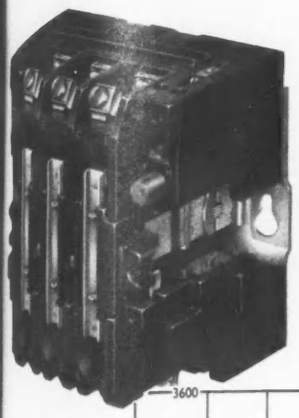
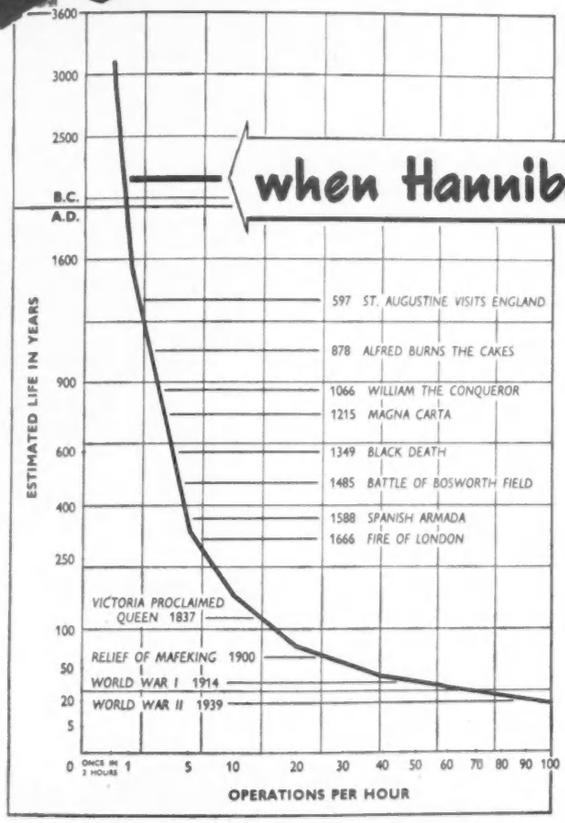


if this CRABTREE starter could have been installed



GRAPH SHOWING TIME TAKEN IN YEARS RELATED TO 4,100,000 OPERATIONS PERFORMED BY CRABTREE TYPE B-15 CONTACTOR (BASED ON A 50-HOUR WEEK AND A 52-WEEK YEAR)

when Hannibal crossed the Alps

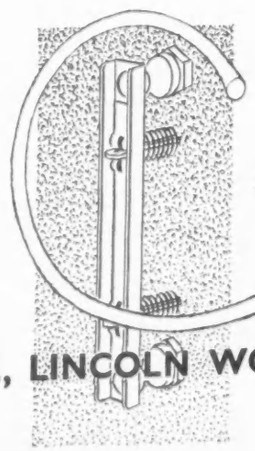
The contacts would now need inspection

ests are now proceeding in which Crabtree ype B-15 starters are being used for epeatedly stopping and starting motors. o date, the starters have given the following perations (start and stop) without change f contacts:

(a) Controlling a 5 h.p. motor: 4,500,000 erations;

(b) Controlling a 1 h.p. motor: 4,500,000 erations.

These tests are continuing.

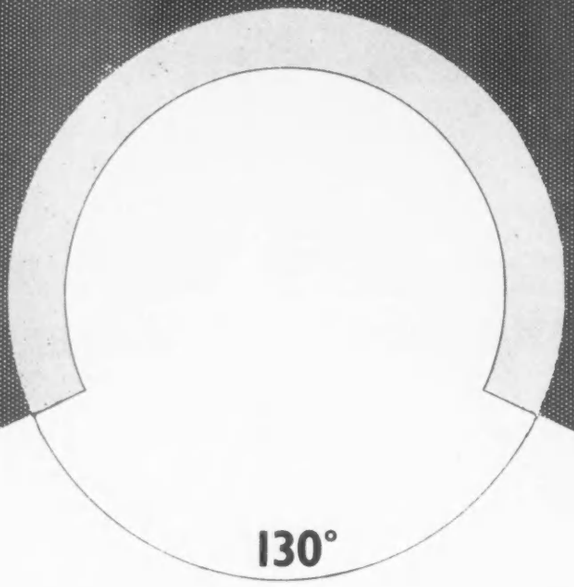


Type B-15 contacts, on actual motor-load life tests, have already achieved 4,500,000 operations (start and stop) and are still giving satisfactory service.

J. A. CRABTREE & CO. LTD., LINCOLN WORKS, WALSALL, STAFFS.

C780

Get more light at no extra cost! fit PHILIPS Reflectalite

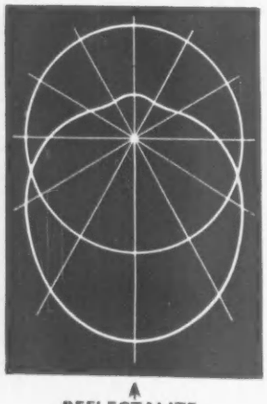


—the fluorescent tube that now gives even more light in the useful direction

Philips "Reflectalite" is the fluorescent tube that defeats light wastage caused by dust accumulation. And today it's a better buy than ever. For, in addition to its basic increase in lighting efficiency, the light output of "Reflectalite" tubes has now been further increased to give you *even more light* in the useful direction. For instance, the 40W Cool White tube now has 10% greater efficiency.

"Reflectalite" has a special built-in reflector covering two-thirds of the internal surface. The major part of the light output is reflected through the 130° 'window' *where it has maximum effect.* (See diagrams.)

STANDARD LAMP



REFLECTALITE

LIGHT DISTRIBUTION COMPARISON DIAGRAM

Available in	SWITCH START
Cool White	4' 40W. 13/9d. plus P.T.
Cool White de Luxe	5' 80W. B.C. or Bi-Pin 14/9d. plus P.T.
Warm White	INSTANT START 1/- extra

Next time you need a tube—fit a

PHILIPS **PHILIPS Reflectalite**

FLUORESCENT REFLECTOR TUBE

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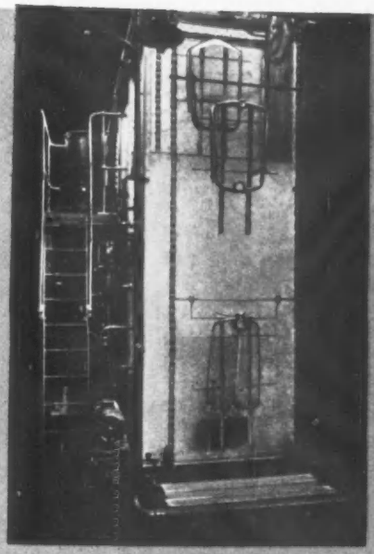
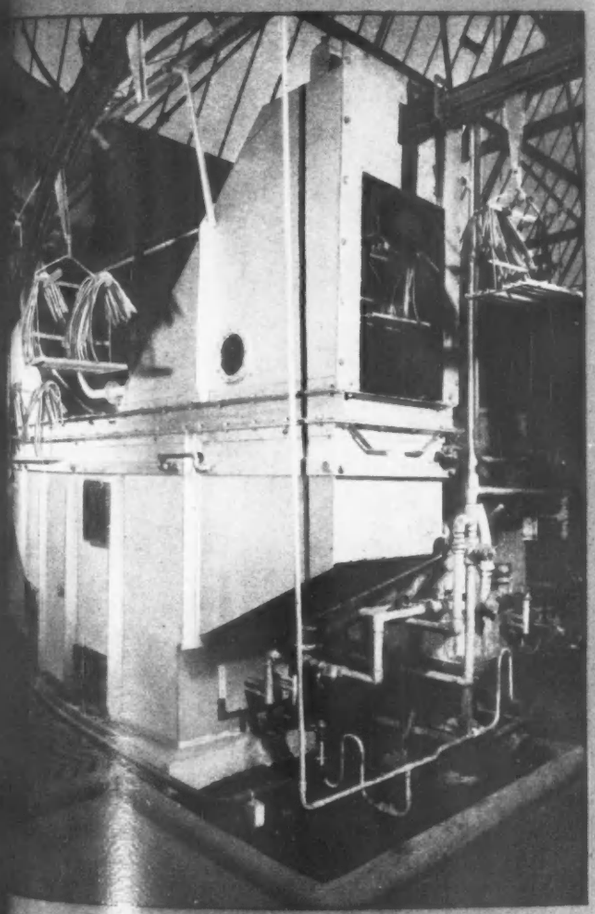


1933

Morris Motors Ltd. installed one of the first-ever continuous I.C.I. metal degreasing plants. This was arranged for degreasing radiator shells, hub caps, etc. after polishing, and provided liquor, vapour and jetting treatment with trichloroethylene. After 24 years this plant continues to give excellent service, degreasing approximately 30,000 assorted articles per week.

One good plant sells another



1956

After many years' practical experience in the design and construction of continuous plants, I.C.I. supplied a second plant fitted with a monorail conveyor to link up with the Firm's production line, and arranged for boiling liquor treatment to remove polishing compound from motor car windscreen and window frames. After leaving the plant, stainless steel parts are packed for despatch while those in brass and mild steel pass to the painting shop.

◀ *The new plant in service.*

For advice on metal degreasing problems, consult

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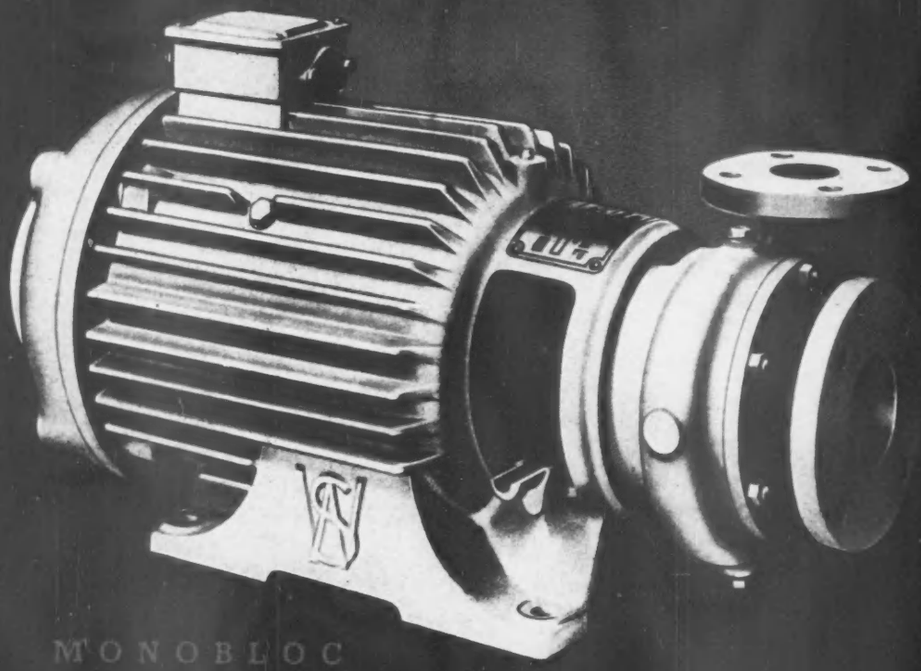
Worthington-Simpson pumps in WORTHITE, superior alloy steel, offer full corrosion resistance to sulphuric and many other acids and alkalis. For pumping mildly corrosive liquids, 18 & 3 Stainless Steel is specially suitable and it will not contaminate or discolour non-corrosive liquids. This range of pumps is of cost-saving Monobloc construction, and the pumps themselves have interchangeable stuffing box glands and mechanical seals to permit simple changes to suit different processes.



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Caustic Potash, 70°F
Caustic Soda up to 50%
Chlorosulphonic Acid,

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Copper Sulphate
Ethyl Acetate, 70°F
Fatty Acids
Formaldehyde, 70°F
Glycerine
Magnesium Sulphate, 5%
Nitric Acid, all concent...
Oleum, up to 120°F
Phosphoric Acid, 10%...
Phosphoric Acid, 85%...
Refinery Crudes
Silver Nitrate, 70°F
Sodium Sulphate, 5%, 70°F
Sodium Sulphide, 5%, 70°F
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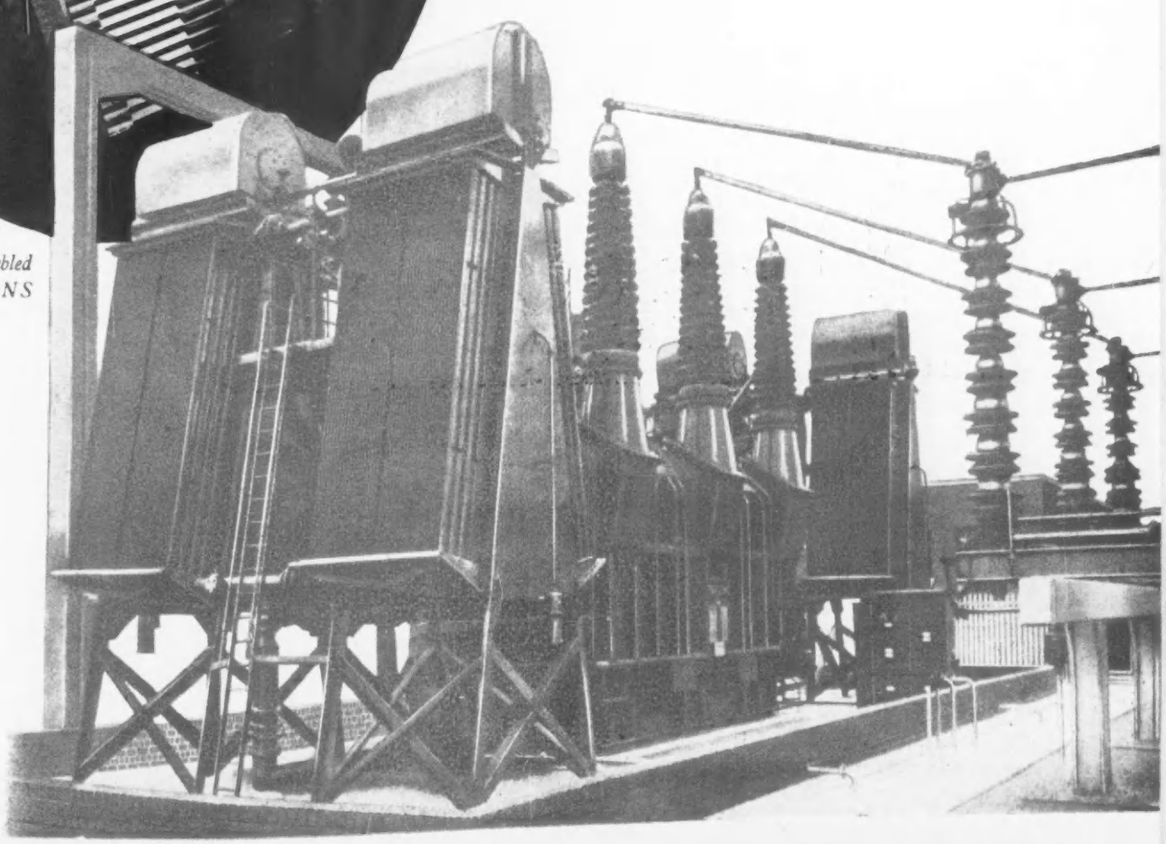
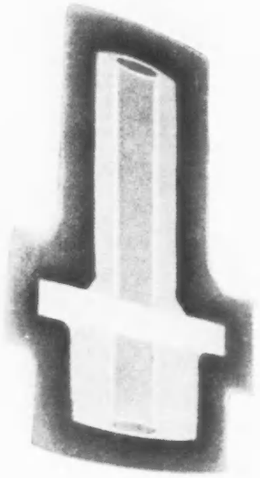
PARSONS

TRANSFORMERS

...the windings on assembled cores of a PARSONS power transformer.



THE FOURTH DIMENSION



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Member Companies of the Birfield Group were some of the earliest in this country to install regular X-ray examination of their products as the 4th dimensional check on the quality of their productions. Up-to-the-minute methods are part of the secret of Birfield Group success. Every Member Company of the Group is backed by the resources—manufacturing and technical—of every other company in the Group.

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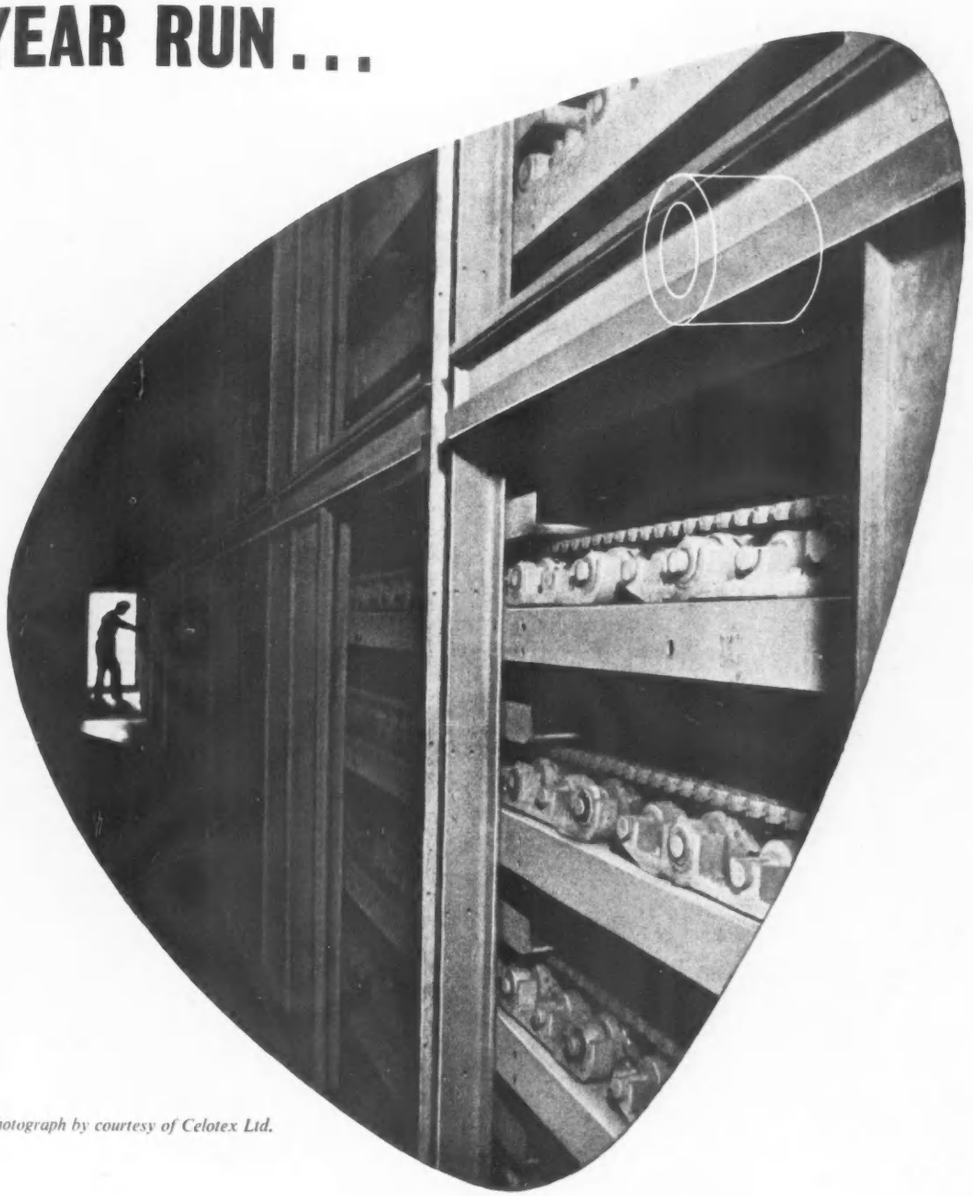
FOUR YEAR RUN...



Photograph by courtesy of Celotex Ltd.

This drying conveyor illustrates one of the many applications of MORGANITE CARBON BEARINGS where carbon is the most suitable material. Thousands of tons of Wallboard pass over these rollers every year—4,000 MORGANITE CARBON BEARINGS undergo severe duty to make this possible—each carries a load of about 30 pounds and is subjected to temperatures up to 650°F in a very dry and dusty atmosphere. In spite of these arduous conditions replacement is only necessary after 4 years.

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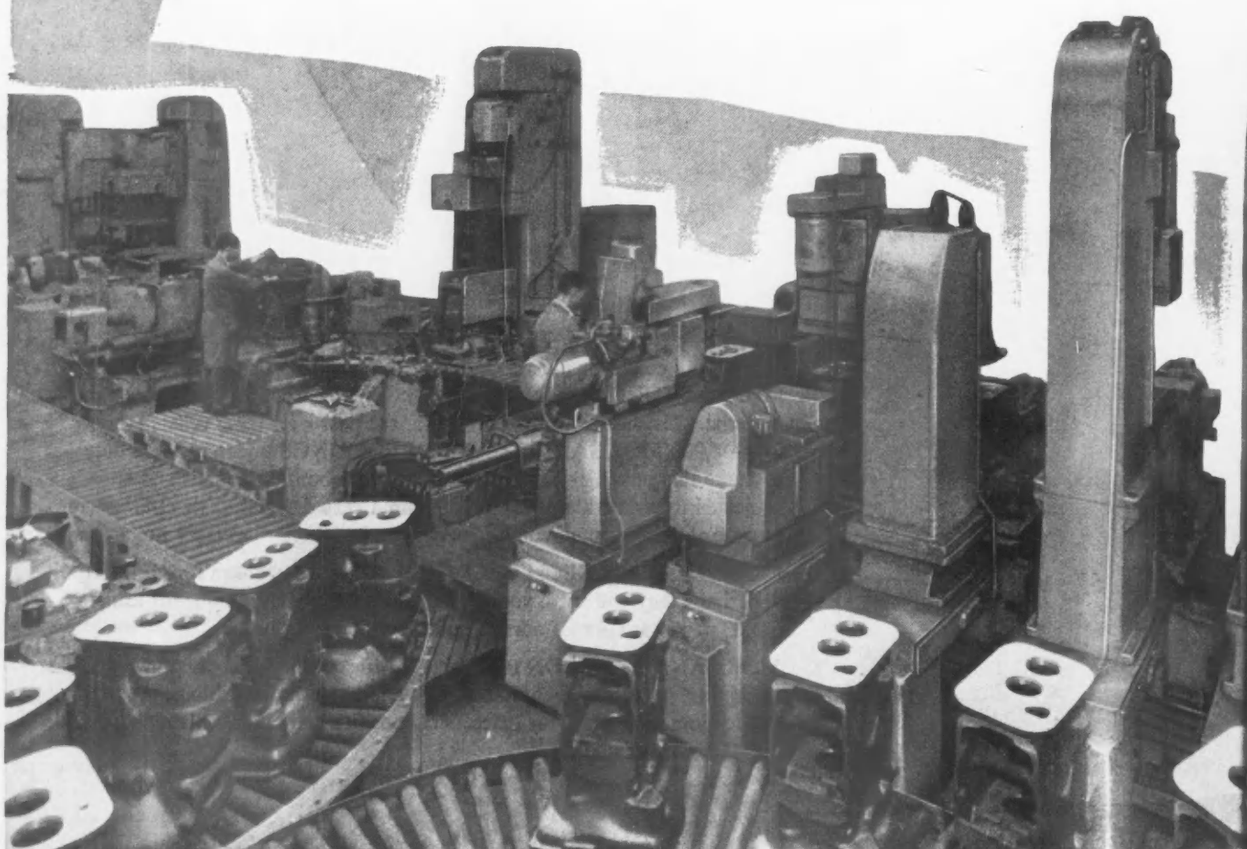
We shall be pleased to submit complete schemes for your consideration. Get in touch with us.



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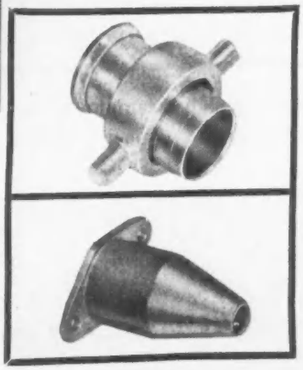

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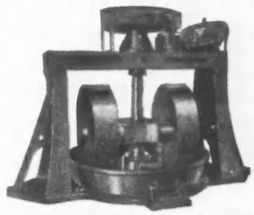

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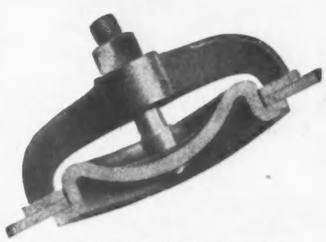

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SPECIAL PROCESS IRONS

Cortite Irons give DENSITY and PRESSURE TIGHTNESS, coupled with HIGH STRENGTH and GOOD MACHINABILITY IN ALL SECTIONS OF THE CASTING in spite of extreme variation of thickness

TYPICAL PHYSICAL PROPERTIES OF "CORTITE" SPECIAL PROCESS IRONS

CORTITE IRON		Minimum TENSILE Strength Tons sq. inch 1·2" diam. Bar	Minimum TRANSVERSE Rupture Tons sq. inch 1·2" diam. Bar	COMPRESSION Strength Tons sq. inch	IMPACT Strength Izod ft. lbs.	BRINELL Hardness No.	Modulus of ELASTICITY lbs. sq. inch × 10^6	SPECIFIC GRAVITY	Coefficient of Thermal EXPANSION Linear × 10^6 0—600°C.	TORSIONAL STRENGTH lbs. sq. inch	FATIGUE STRENGTH Tons sq. inch	The equivalent British and American Standards	
Class	Grade											B.S.S. 1452/1956	A.S.T.M.
HIGH DUTY ENGINEERING	E	14	26	56	10	170–190	12–15	7·20	—	—	5·0	14	25-30
	D	17	30	68	15	180–210	16–18	7·25	—	34,000	7·0	17	35-40
	C	20	36	75	20	200–240	18–20	7·40	—	51,000	9·0	20	40
	B	23	40	80	25	220–280	18–20	7·45	—	60,000	10·0	23	50
	A	26	45	90	30	260–340	18–20	7·45	—	73,000	11·0	26	60
HEAT RESISTING	HR.1	14	26	56	10	100–170	10–12	7·00	12·8	—	—	—	—
	HR.2	20	36	75	20	200–240	18–20	7·40	12·8	—	—	—	—
	HR.3 (Silal)	12	—	—	—	210–280	17–45	6·9–7·2	12·9	—	—	—	—
WEAR RESISTING	W.R.B.	20	36	75	20	240–280	18–20	7·40	—	—	—	—	—
	W.R.A.	26	45	90	30	260–340	18–20	7·45	—	—	—	—	—
CORROSION RESISTING	C.1	18	30	62	10	180–210	12–15	7·15	—	—	—	—	—
	C.2	15	28	58	10	180–210	12–15	7·15	—	—	—	—	—

TYPICAL APPLICATIONS OF "CORTITE" SPECIAL PROCESS IRONS

CORTITE IRON		TYPICAL APPLICATIONS	Minimum Casting Thickness	HEAT TREATMENT (optional)
Class	Grade			
HIGH DUTY ENGINEERING	E	Gear Cases, Light Valves, Gears, Electrical Components, Bogie Wheels, etc. ; in fact, wherever a soft grey iron is called for.	1/8"	For stress relief heat slowly to [illegible]. Hold at this temperature for one hour per inch section. Cool slowly.
	D	Valve Bodies, Gates, Covers, Medium Machine Bedplates, Chucks, Gears, and Housings ; Cylinder Liners, Blocks, and Manifolds. All medium size high-pressure castings.	1/4"	
	C	Turbine Casings, Condenser Bodies, Tyre Moulds, Marking-off Plates, Propellers, Flywheels, Pump Bodies, Pistons, Large High-pressure Valves, Steam Chests, Biological Shields, Gears, Large Machine Bedplates, Headstocks, etc.	3/8"	For improved strength and toughness heat at 850° C and temper at 300° C. To relieve quenching stresses Grades C and B
	B	Diesel and Compressor Bodies (handling high-pressure ammonia and Freon gas), High-pressure Valves, Oil Well Castings, Slush Pumps, Gears, Machine Tool Components, Rocking Links, Highly Stressed Hydraulic Castings, Winch and Winding Drums, Rolls, etc.	1/2"	
	A	Crankshafts, Camshafts, Mixershafts, Dies, Rolls, Atomic Engineering Pressure Vessels, Shields, and Casings ; Brake Drums, High-pressure and High Strength Castings.	1/2"	For high tensile and machinability heat at 300–350° C, for six hours plus one hour per inch of thickness.
HEAT RESISTING	HR.1	Intermittent Heat and Severe Thermal Shock, Chills, Ingot Moulds, Slag Pots, Annealing Glass Moulds, Fire Doors, Casings, Pig Moulds, Melting Pots, etc.	3/8"	—
	HR.2	High Duty Castings for use at temperatures up to 550° C, High-pressure Valves, Superheater Headers, Glass Moulds, etc.	1/2"	—
	HR.3	Castings working at temperatures up to 900° C, Valves, Fire Bars, Annealing Boxes, Furnace Parts. These castings are brittle at room temperature.	1/2"	—
WEAR RESISTING	WR.B	Chute Liners, Crane Wheels, Mill Wheels and Blades, Mixing Pans, Gears. Easily machinable.	1/2"	Can be oil-quenched at 850° C and tempered at 300–500° C.
	WR.A	Mixer Blades, Wheels and Pans, Die Blocks, Cams, Gears, Liners, Rolls. High strength coupled with abrasion resistance.	1/2"	For high hardness castings, to improve machinability hold at 300°–350° C, for six hours plus one hour for each inch of thickness.
CORROSION RESISTING	C.1	Concentrated acid-resistant Pumps, Valves, etc.	1/4"	—
	C.2	Alkali-resistant Pumps, Valves, Caustic Pots, Evaporators, etc.	1/4"	—

New Alloys and Metallurgical Techniques employed in the process of producing these irons ensure consistent results, so that designers may rely upon the accuracy of the technical information given on the chart

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CORTS THROTTLE VALVE—GRADE C.

PUMP CASTING—GRADE D.—(For Hayward, Tyler & Co., Ltd., Luton).

This 53 cwt. Vertical Compound Oil Cargo Pump is for use in tankers and handles 750 t.p.h. of oil. It is tested at 350 lb. p.s.i. for a working pressure of 200 lb. p.s.i.

All the cores and the mould are made by the CO_2 process, which gives an excellent finish and ensures that the dimensions of cored holes are exact.

COMPRESSOR CYLINDER FOR REFRIGERATION EQUIPMENT—GRADE B.—(For Lightfoot Refrigeration, Ltd., Wembley).

This 15½ cwt. six-cylinder freon compressor casting must be completely flawless. The cylinders and crankcase, which are cast in one piece to ensure perfect alignment, are subject to hydraulic tests of 300 and 600 lb. p.s.i. respectively and gas tests of 250 lb. p.s.i.

MIXERSHAFT — GRADE A.—(For Winkworth Machinery, Ltd., Staines).
This Casting must be very strong, and 100% sound, to withstand severe Torque, replacing a steel casting.

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For use in hot gas main at temperatures of 550 -600° C.

BEDPLATE FOR GEAR CUTTING MACHINE—GRADE C.—(For W. E. Sykes, Ltd., Staines).

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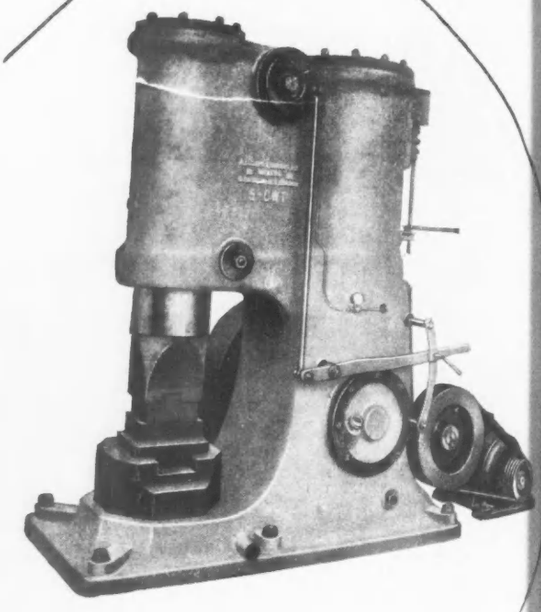

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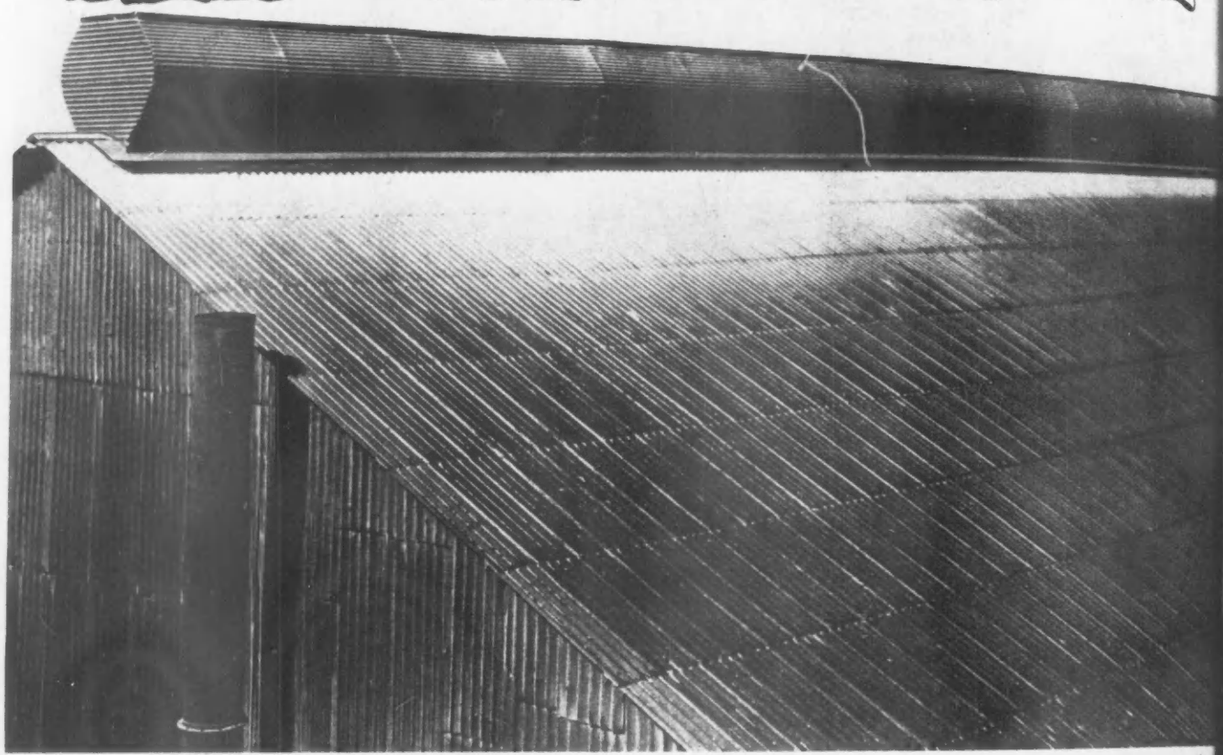

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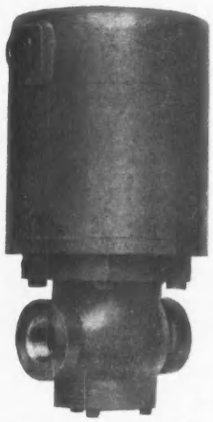

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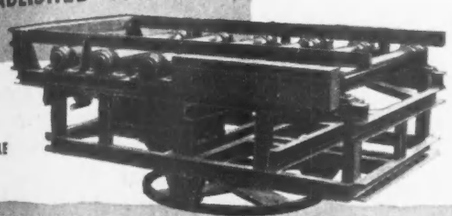

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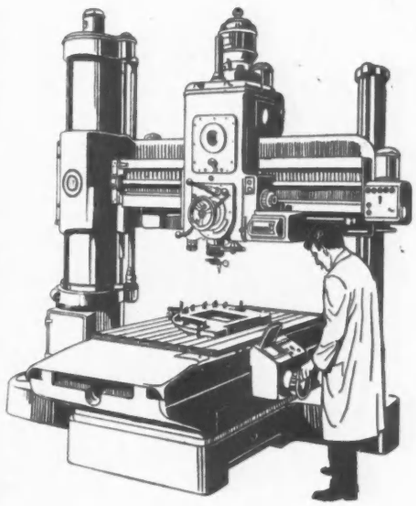

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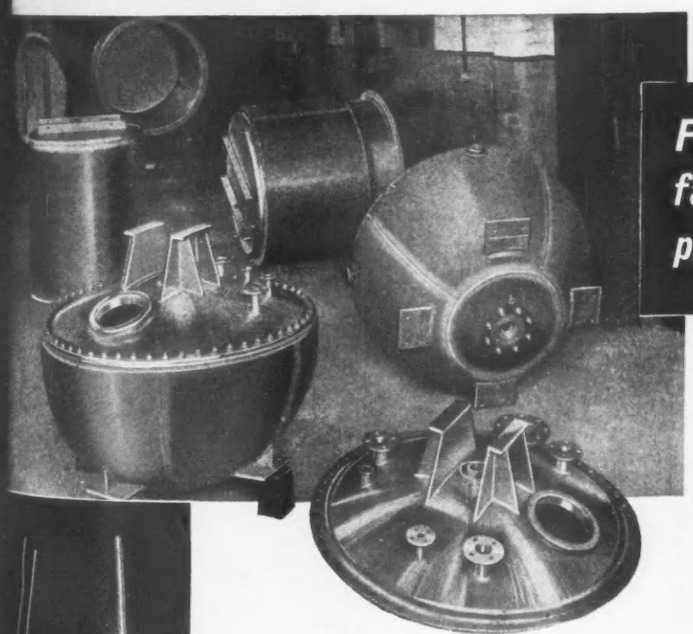

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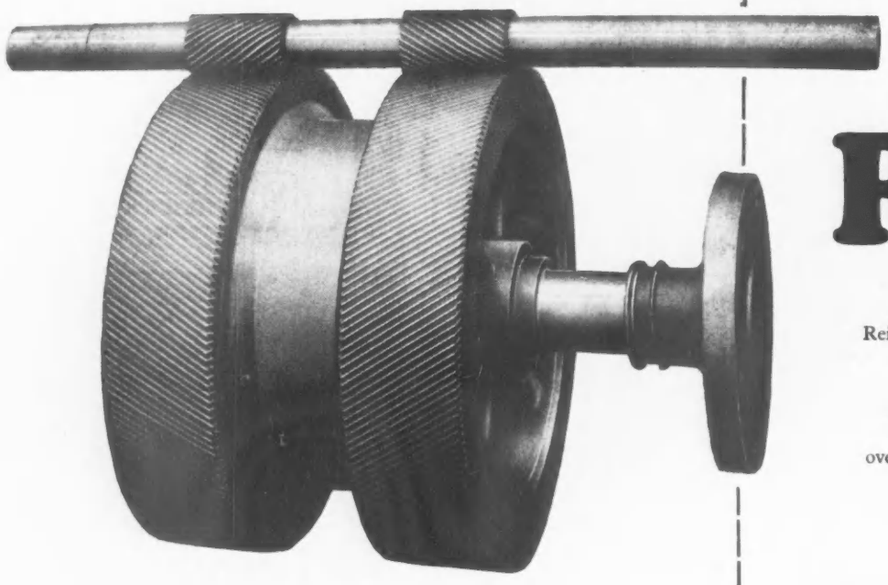

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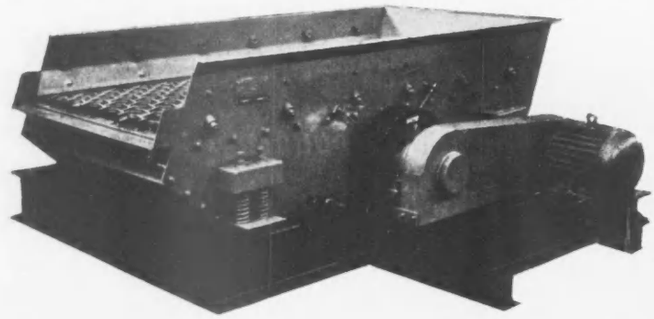

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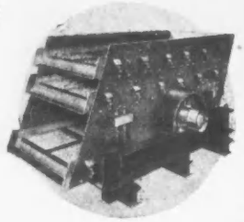

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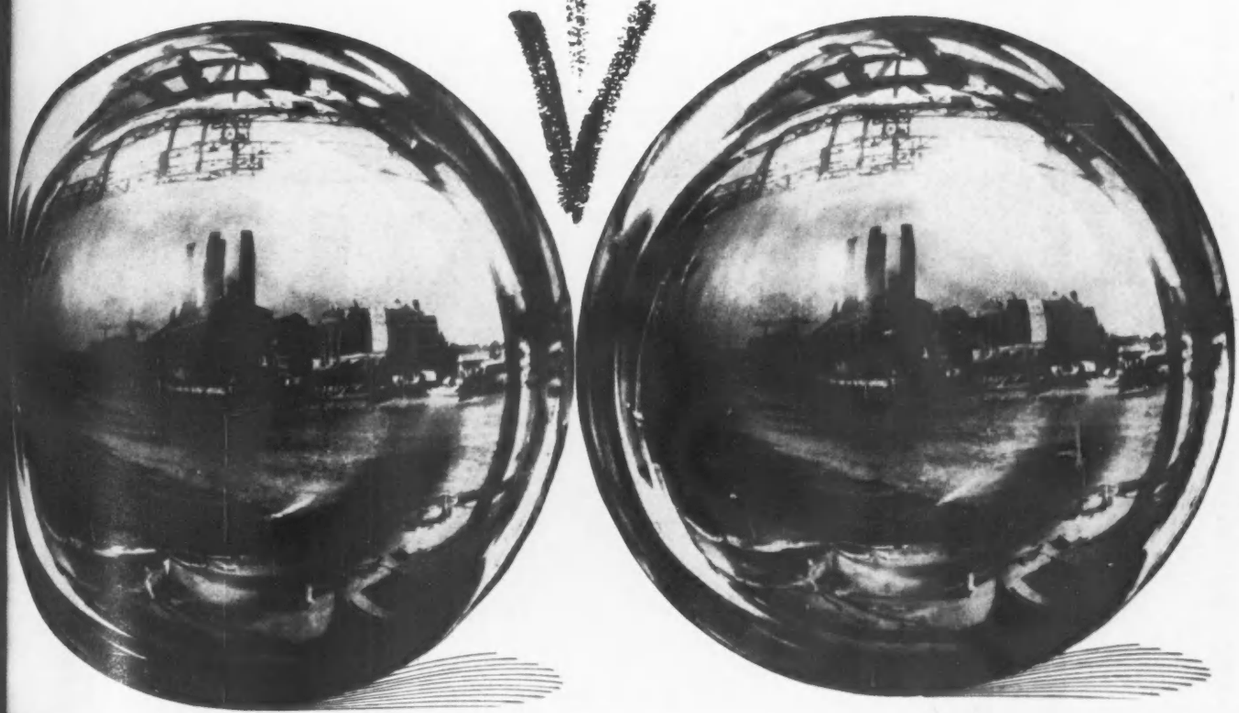

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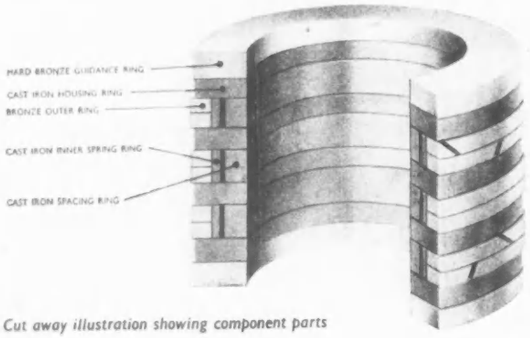

Cut away illustration showing component parts

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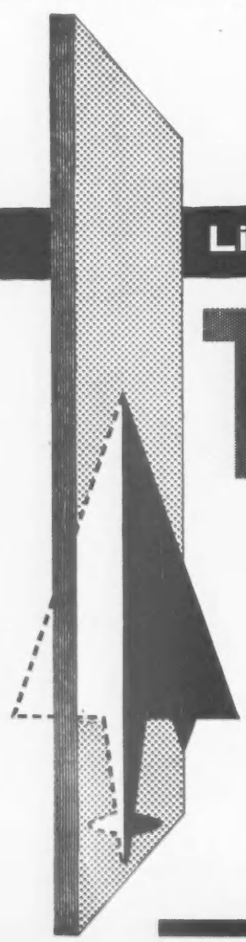

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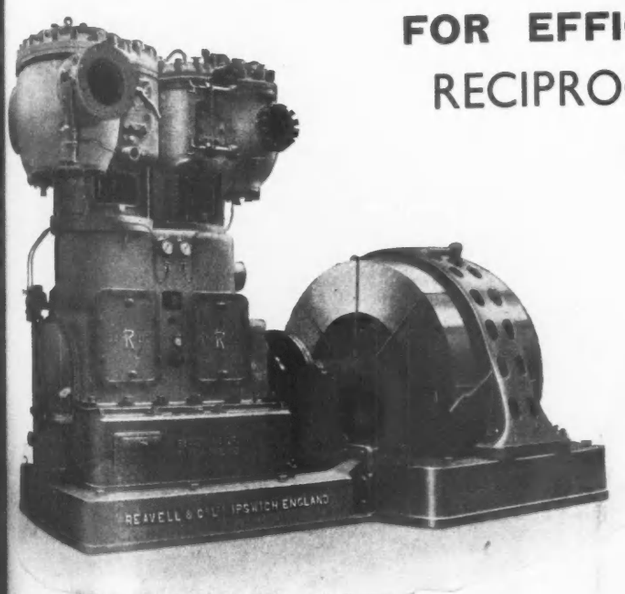

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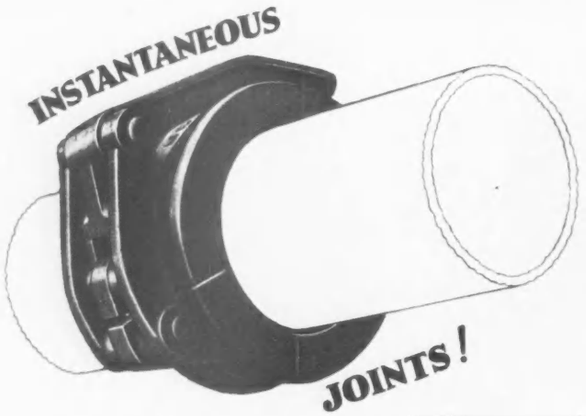

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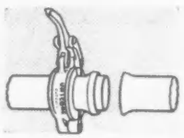
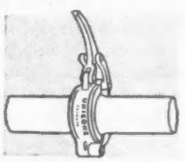
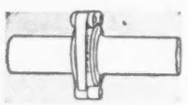


Rubber gasket in position and joint ready to pull over.



Pipe ends joined ready for locking.



The completed joint.

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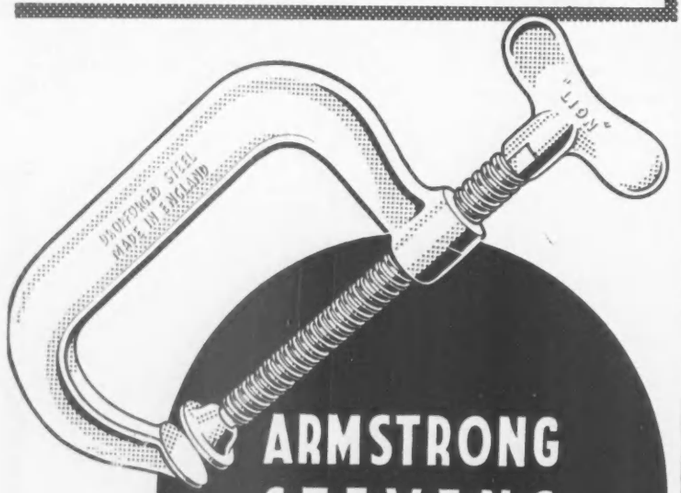

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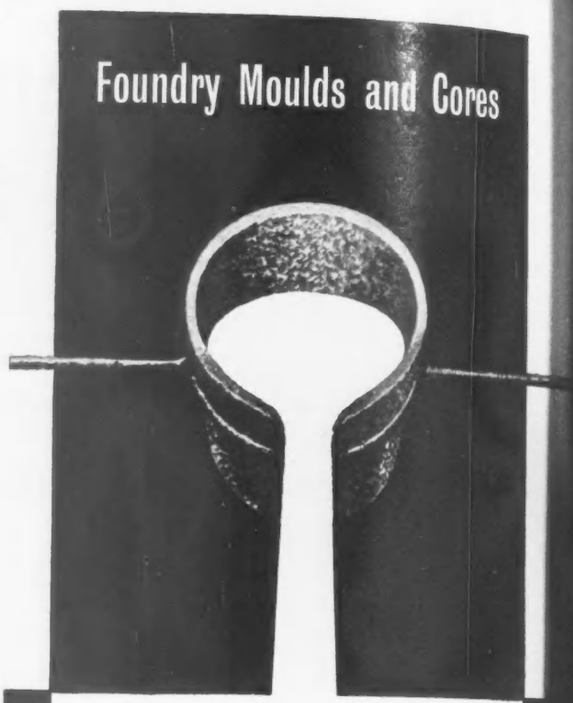

I.C.I. and the CO_2/Silicate Process

(BRITISH PATENT No. 654,817)

During the past few years, the many technical advantages of this new process for making foundry moulds and cores have attracted much attention in the foundry trade in spite of doubts that have so far surrounded the future of British Patent No. 654,817, which covers the process. An application by the patentees for the restoration of this patent was made in October 1954, and this application will shortly be considered by the Patent Office.

Imperial Chemical Industries Limited announces that, to achieve the full development of the process in the United Kingdom, an agreement has recently been concluded with the patentees (Vitkovicke Zelezarny Klementa Gottwalda and Dr. Ing. Lev Petrzela), under the terms of which, if the patent is restored, a free licence will be available to all. Moreover, I.C.I. will receive all the technical information already in the possession of Vitkovicke and any that becomes available from their continuing research work.

As a supplier of carbon dioxide and sodium silicate, I.C.I. is anxious to assist in developing further the carbon dioxide/sodium silicate process in the United Kingdom, and to this end, technologists have already visited major foundries and research organisations in Czechoslovakia. The detailed information that ten years of intensive development of the process have established there will thus supplement the already extensive knowledge that I.C.I. has acquired in this country. The comprehensive and efficient technical service of I.C.I. is now augmented by the close contacts with the inventors, and as always, is at the disposal of the foundry trade.

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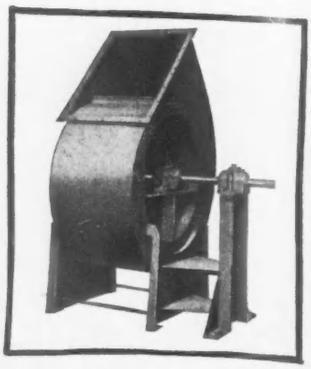

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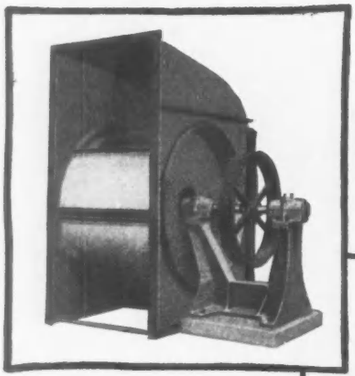

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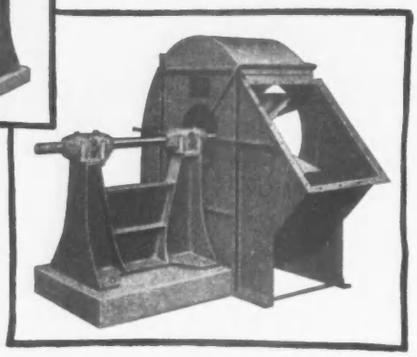

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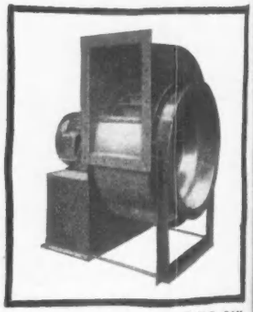
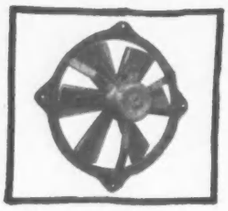
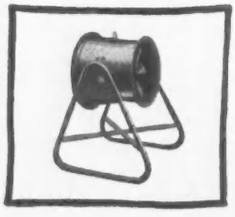


P.V.C. FAN.



PROPELLER FAN.



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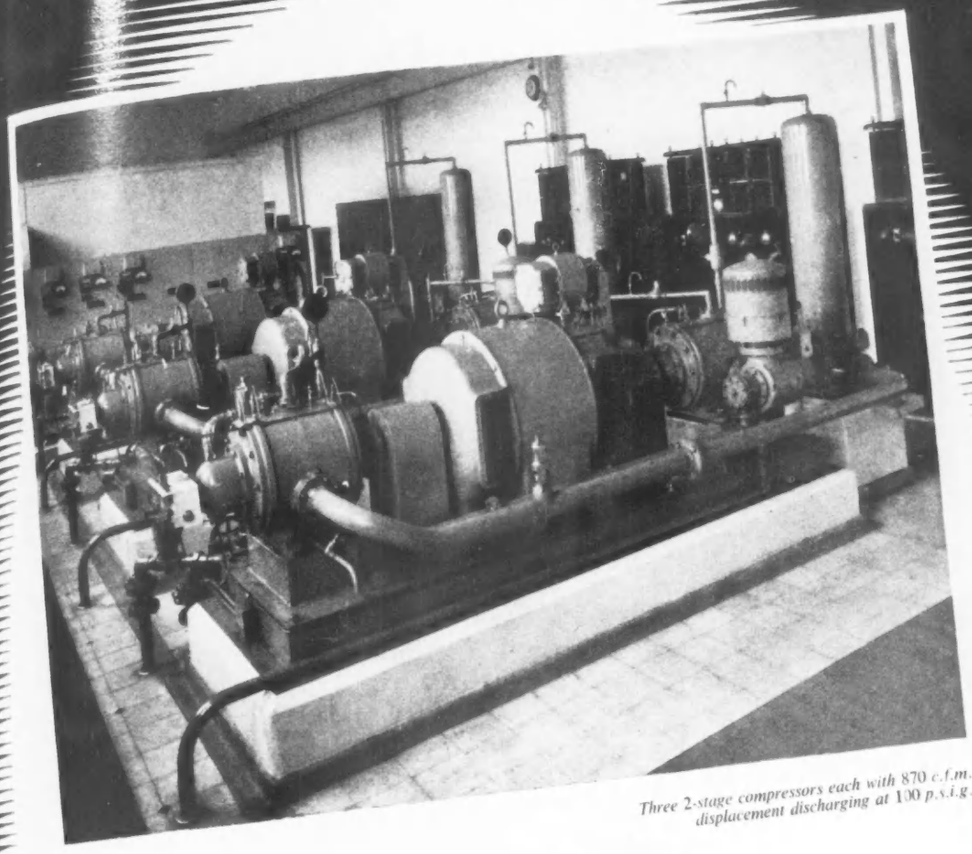

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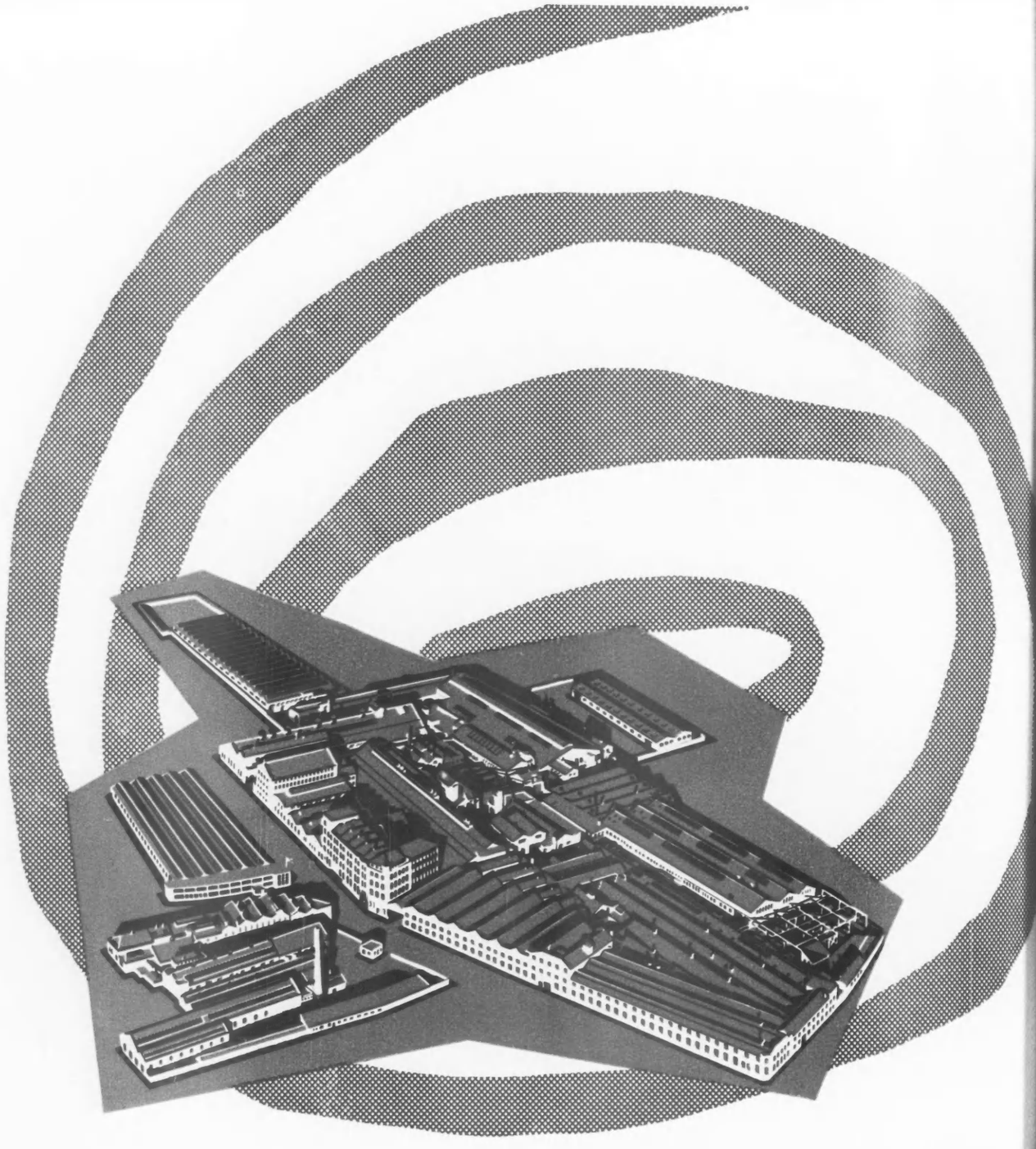

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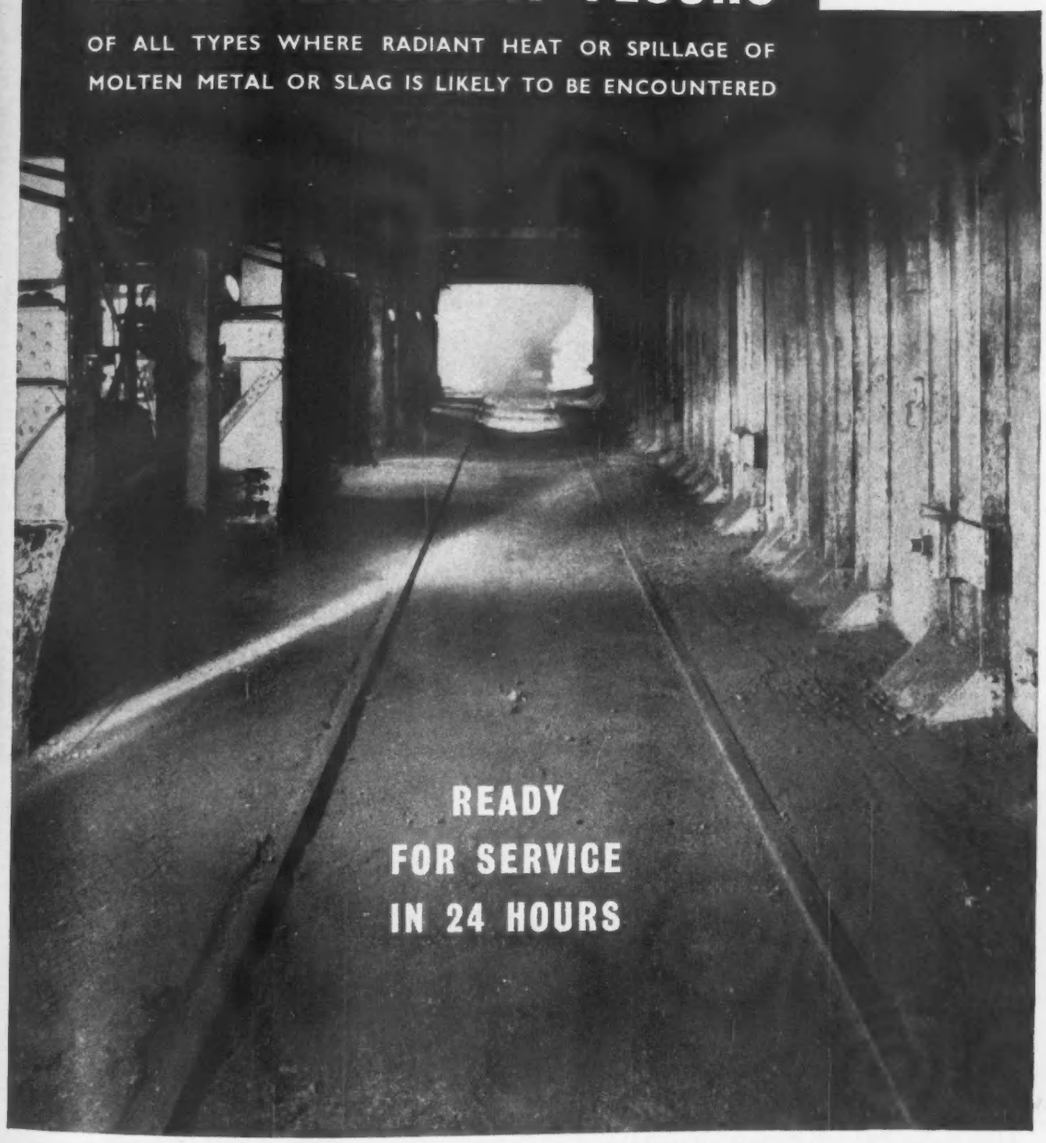

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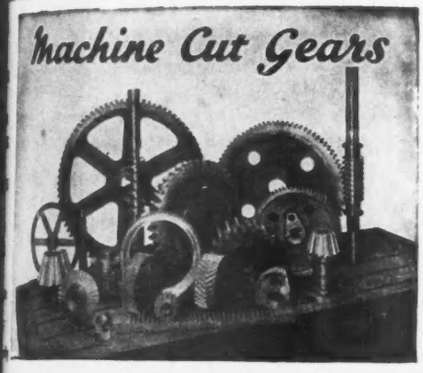

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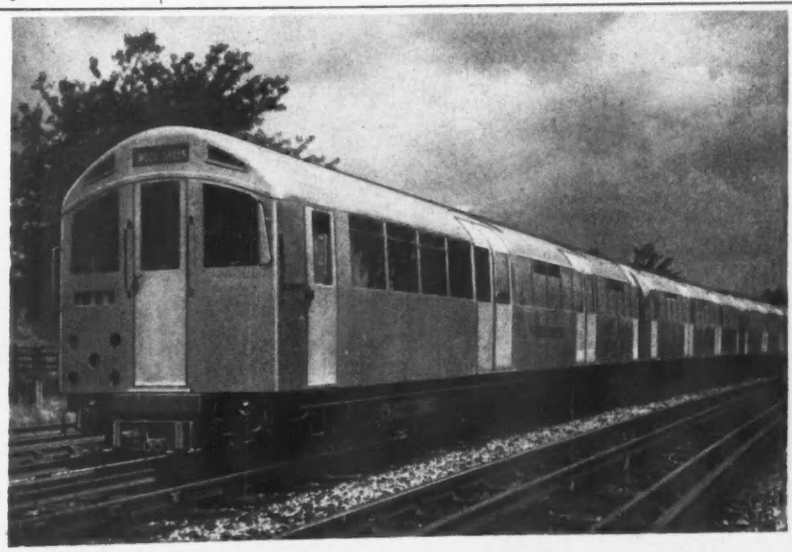

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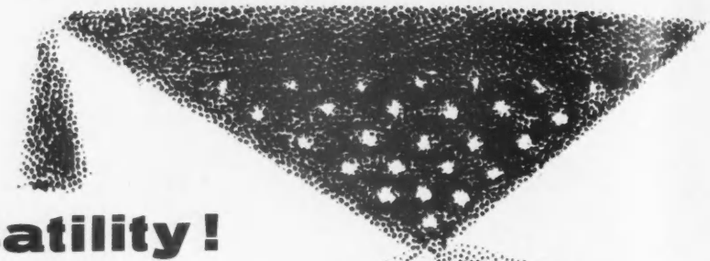

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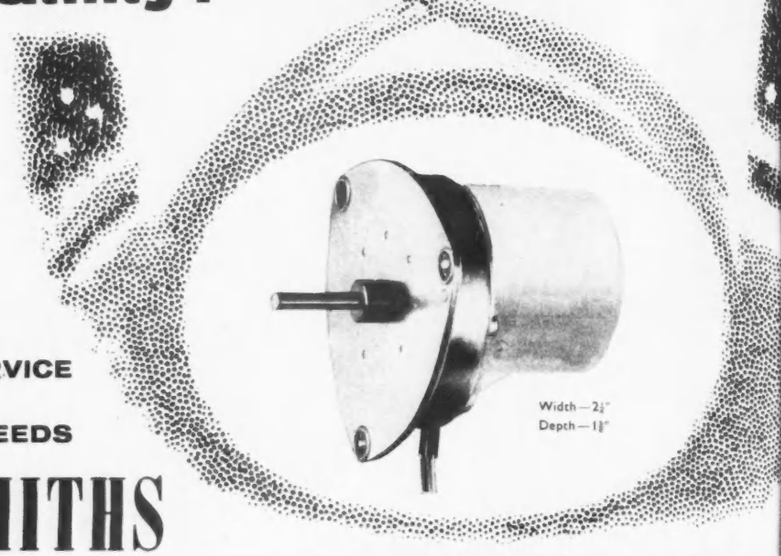

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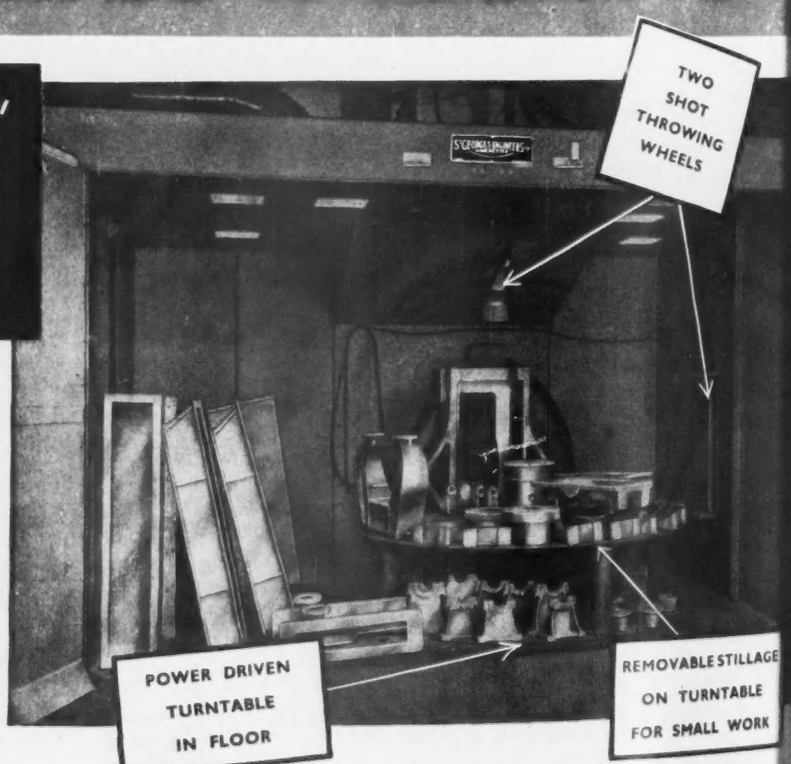

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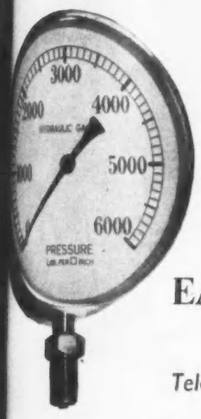

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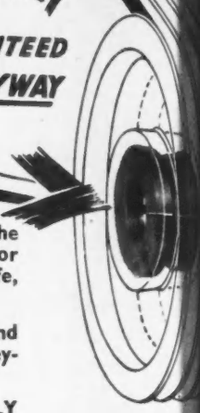

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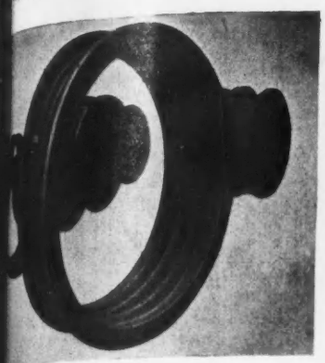

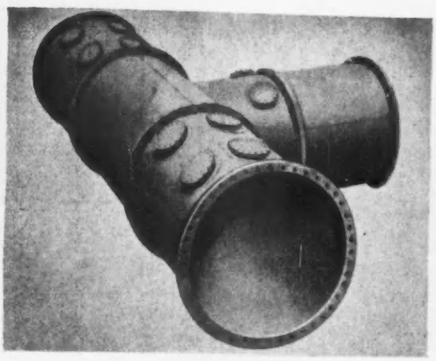

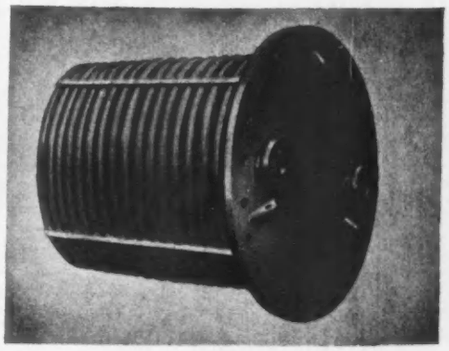

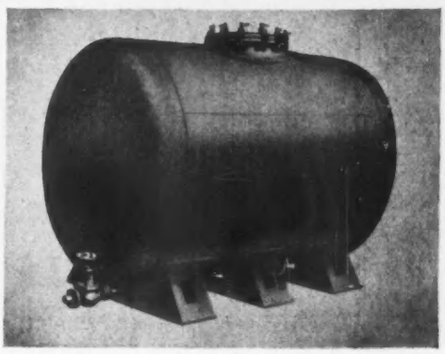

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After leading the field for over a hundred years in the fabrication of copper vessels, expansion joints, etc. Clarks of Hull have now—to cater fabrications in stainless steel, mild steel, aluminium, etc. —erected a completely new Fabrication Shop. Newly-equipped with the most modern processes and staffed with hand-picked, highly-experienced personnel, Clarks' Fabrication Shop is in a position to combine excellent deliveries with high standards of workmanship —probably giving you more for your money too! A skilled design service is available.

- **Metallic Arc Welding**
- **Argonaut and Argon-Arc Welding**
- **Stress-relieving and testing facilities**
- **Agents or representatives in all parts of the country**

Plate preparation bay—new Fabrication Shop

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EVERY TYPE OF WELDED FABRICATION

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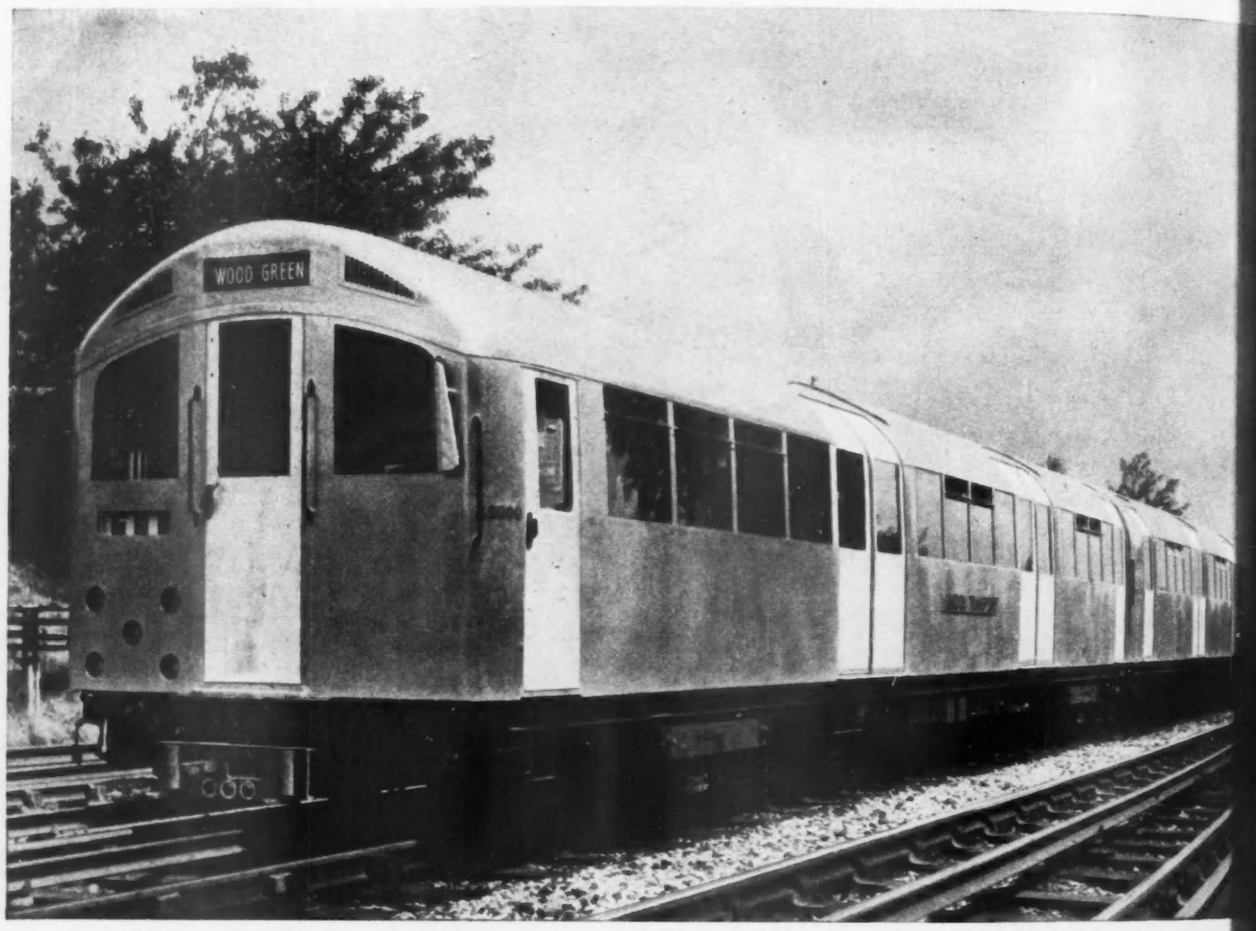
HAWTHORN AVENUE · HULL
Telephone: 37654 Telegrams:"Clark, Hull"

A MEMBER OF THE NEWMAN HENDER GROUP

BRITISH ALUMINIUM

ON THE PICCADILLY LINE



London Transport prototype tube train

The London Transport Executive are trying out three prototype tube trains with unpainted aluminium alloy outer panelling. British Aluminium was chosen by the manufacturers of two of these trains—Metropolitan-Cammell Carriage & Wagon Co. Ltd., and Gloucester Railway Carriage & Wagon Co. Ltd.
The use of aluminium saves half a ton of deadweight per car—correspondingly reducing power consumption—eliminates about three cwt of paint, plus labour costs per car, and lowers cleaning costs.

The BRITISH ALUMINIUM Co Ltd

NORFOLK HOUSE ST JAMES'S SQUARE LONDON

MARBAIX
FOR UNUSUAL MACHINES

MINUTES SLASHED TO SECONDS . . .

on the new

MARBAIX
M58 DISINTEGRATOR

- REMOVES BROKEN TOOLS WITHOUT DAMAGE TO THE COMPONENT
- CUTS HOLES OF ANY SHAPE IN HARDENED MATERIAL, CARBIDES ETC.

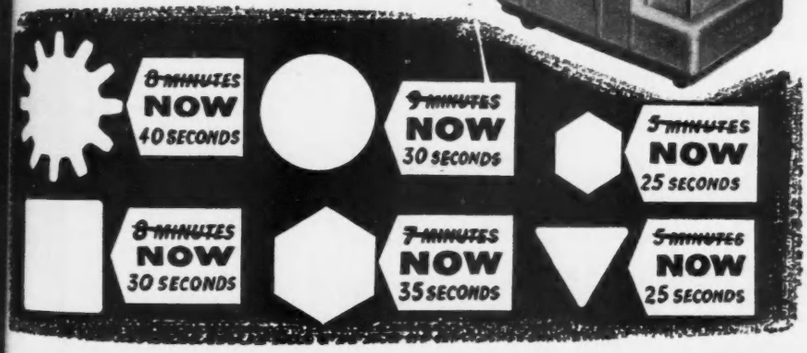
. . . in fact any material through which electric current can pass.

The new MARBAIX M.58 disintegrator removes broken taps, drills, reamers, studs, etc., in a fraction of normal time, without damage to the component.

Holes, too, of any shape can be cut in hardened material, for subsequent finishing by grinding or other methods. Note the times for the various examples shown, and write today for full details to DEPT. E.1.

DEMONSTRATIONS ON YOUR OWN COMPONENTS GLADLY GIVEN.

★ HERE'S HOW TO CUT COSTS
Times obtained on Model M58-C (as illustrated)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MARBAIX INDUSTRIES LTD
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PHONE: BATTERSEA 8888 (8 lines)

BRETT'S PATENT LIFTER Co LTD
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Phone 89038 Grams "LIFTERS" COVENTRY

RE

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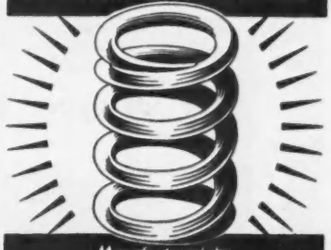
EXTREMELY ACCURATE PLATE CAMS

ELECTRONICALLY CONTROLLED CAM MILLING MACHINES

SPECIAL PURPOSE MACHINES

Research Engineers Ltd.,
CANONBURY, N.1
CAN 4244/5/6
Telegrams: "Wilmaket, Nordo, London"

SPRINGS AND SPRING WASHERS
FOR ENGINEERING PURPOSES



Manufactured by
JOHN TONKS & CO LTD.
CENTRAL SPRING WORKS
Furnace Hill, SHEFFIELD, 3
Telephone: SHEFFIELD 29679
Telegrams: TONKS SHEFFIELD 3

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NEALED IN THE MOST MODERN SEOUS DECARBURISING PLANT

Excellent Physical Properties

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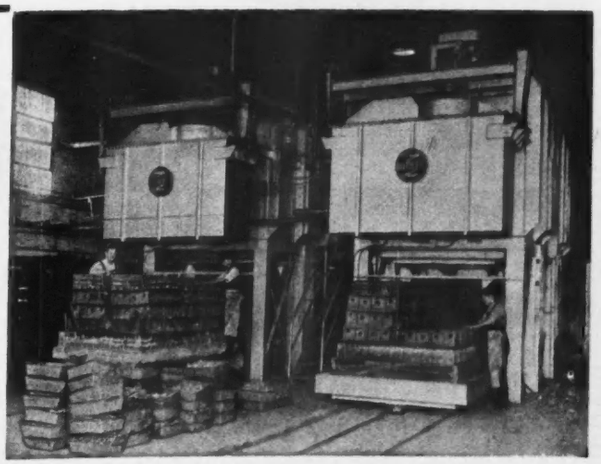
E FOUNDRY · LEAMORE · WALSALL



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(When fitted in room with white ceiling) gives 10% to 15% Extra Lighting Value

Non-inflammable. Instantly detachable and adjustable. Weight 9ozs.

The wide open top of the shade allows for a greater circulation of air, which keeps the lamps and wiring installation at their coolest, thus creating a good safety factor against shorts.

PROTECTAFIL *as illustrated*

SHOCK ABSORBERS *See arrow*

Britain's Best Anti Vibrator Lamp Fitting

OVER QUARTER OF A MILLION IN USE

Suitable for all lighting points Dispersive and Fluorescent. VIBRATION causes a large number of lamps in industrial installations to fail prematurely. You will find an easy solution in the use of PROTECTAFIL.

TREBLES THE LIFE OF YOUR LAMPS

*Send for illustrated Catalogue T.E. and a sample PROTECTAFIL

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Warren-Morrison experience in design and production of specialist valves has led to the introduction of this range of diaphragm valves. Designed for the widest possible range of duties they incorporate many features appreciated by the operator. From a safety point of view this valve will shut off, even if the diaphragm does fail. For convenience, a visible position indicator is fitted. From the long-life angle the valve is heavily made, using only the best of materials and workmanship. For the really difficult jobs 'all-P.T.F.E.' diaphragms are available; another example of W.M. leadership in valve design. Electric or pneumatic operation is available, of course.

WARREN-MORRISON LTD

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Don't look now, but we're being followed.

Blonde or brunette?

This one's tawny with a rather original hair-do.

The most striking thing about her, though, is her figure.

34, 24, 34?

No, old man—48, 35, 23. And not a seam or a weak spot anywhere.

She's no kitten!

How right you are!

We invite your enquiries—

for all types of rubber hose.

This rough bore SUCTION HOSE is built from rigorously tested materials with accurately pitched spiral bore. Corrugated or smooth surface as required. External armouring and fitted couplings if desired. For hoses to *your* special requirements get in touch with

CLYDE RUBBER WORKS LTD.

SPECIALISTS IN RAILWAY ROLLING STOCK EQUIPMENT

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Telephone: RENFREW 2384 Telegrams: RUBBER, RENFREW Telex. 77-107

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Chesterfield have the ... share of the very big ... tube business. The ... separator illustrated ... external dimensions of ... 48½ - 34¾ ins., and ... 23 ins. It is 15 ft. long ... works safely at a pressure ... 5,150 lbs. per sq. in. ... Only from Chesterfield ... get such hefty—and ... strong—seamless steel ... tubular products!

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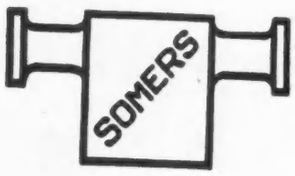
THE CHESTERFIELD TUBE COMPANY LIMITED · CHESTERFIELD · ...

Walter Somers Limited



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Marine, Electrical and General Engineering Industries

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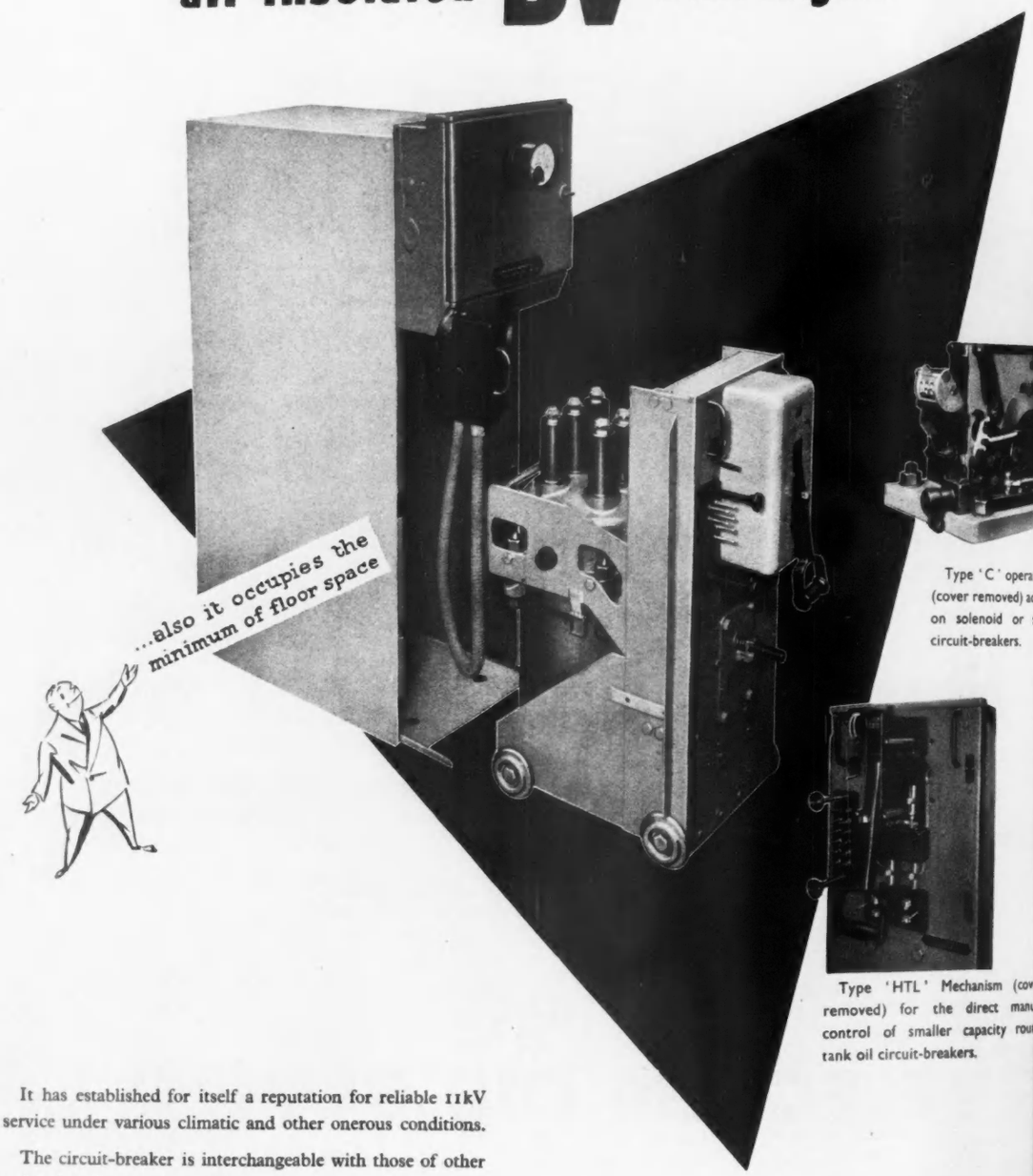
HAYWOOD FORGE · HALES OWEN · NR. BIRMINGHAM

Telephone: Hales Owen 1185

Reasons for the popularity of air insulated BV Switchgear



Type 'C' operati (cover removed) ada on solenoid or sp circuit-breakers.

Type 'HTL' Mechanism (cov removed) for the direct manu control of smaller capacity rou tank oil circuit-breakers.

It has established for itself a reputation for reliable 11kV service under various climatic and other onerous conditions.

The circuit-breaker is interchangeable with those of other units of similar current ratings.

A system of well-designed interlocks ensures the safety of the operator in all reasonable circumstances.

These, and others we would be happy to elaborate upon, are the reasons, for the popularity of BV Switchgear, which may be found in service in all parts of the World.

Solenoid or spring mechanism supplied for all ratings, though ha mechanisms are normally supplie rating of 150 MVA.

Ferguson Pailin LIMITED *for Switchg*

An A.E.I. Company

Head Office & Works: **HR. OPENSHAW MANCHESTER 11,** *Telephone* : DROylsden 1301 (Pte.Branch Ex)

LONDON OFFICE : Bush House, Aldwych, W.C.2 BIRMINGHAM OFFICE : Windsor House, 656 Chester Road, Erdington, 23 GLASGOW OFFICE : Central Chambers, 109 Ha

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But not if you fix a Kolok Positive Lock Washer between them. Here's the inexpensive solution to vibration and slackness worries—and there is a size for every requirement.

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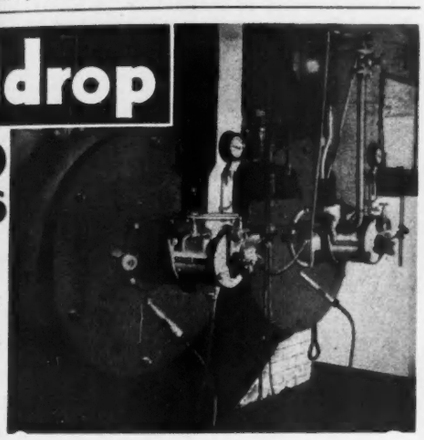

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Rubber Components for the more Exacting Applications

Our wide experience in the field of precision rubber engineering qualifies us to advise on the rubber compounds and design of components to meet the more exacting applications.

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Producers of Rubber Mouldings to fine dimensional tolerances and officially approved specifications

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AT THE LOWEST RATES IN EUROPE

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AUTOHALL BREAKS THE PRICE BARRIER

Now you can hire a new car at lower cost than you can own one yourself!

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SHORT TERM HIRE 4 to 11 WEEKS from £3. 12. 0. per week, allowing 200 FREE miles.
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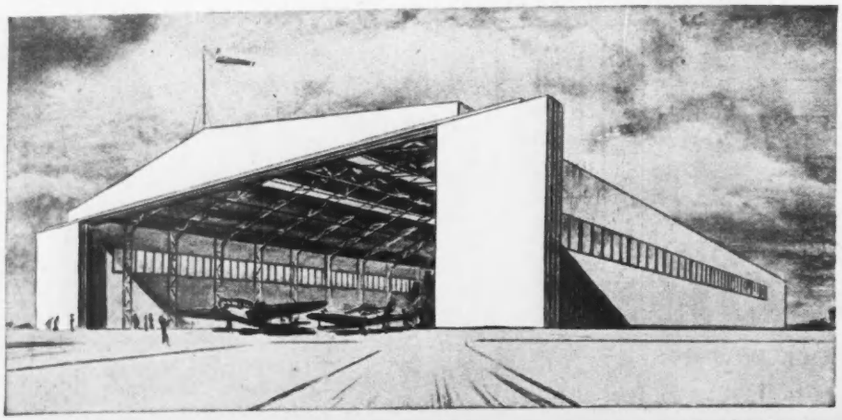

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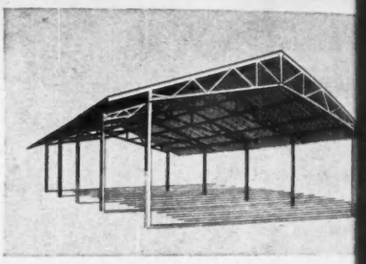

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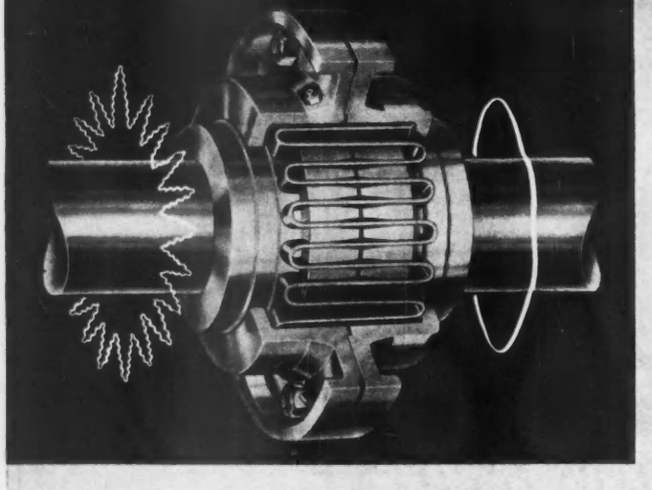

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The **BIBBY** *Resilie* COUPLI

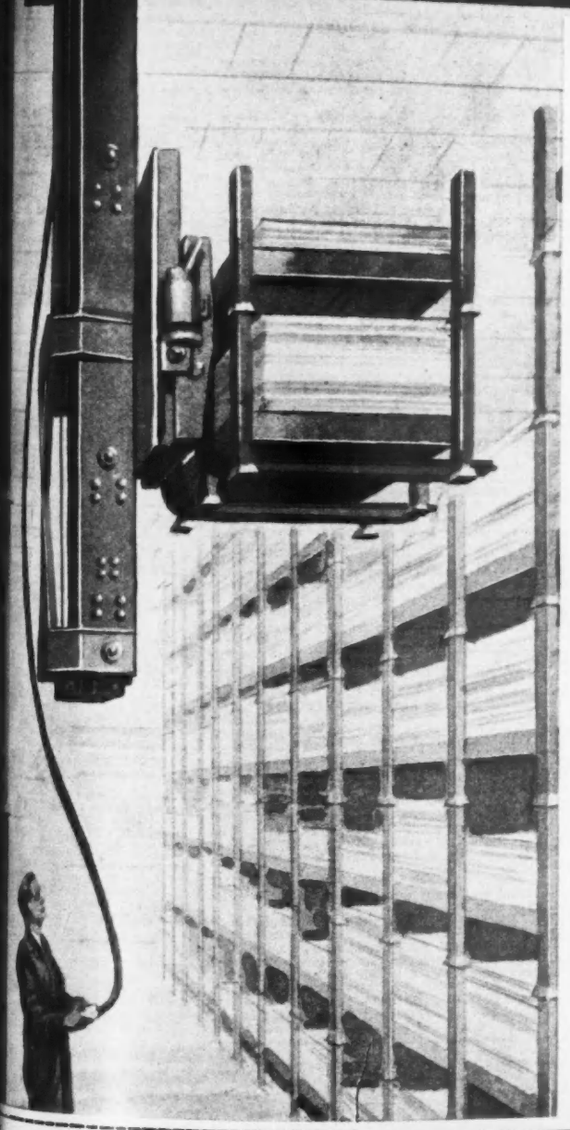
Breakdowns, heavy production losses, and high maintenance costs are reduced to a minimum. Maximum outputs are ensured.

The unique resilience of Bibby Couplings protects and lengthens the life of machinery by absorbing shocks and vibrations, and accommodating unavoid angular and parallel misalignments.

There is a Bibby Resilient Coupling for every d

We invite you to write, today, for our illustr brochure.

THE WELLMAN BIBBY COMPANY LIMITED, PARNELL HOUSE, WILTON ROAD, LONDON, S



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Now, with a KING SKI-WRACKER you can make every foot of overhead space pay its way. Specially designed to operate in confined spaces where floor-mounted equipment could not, the versatile SKI-WRACKER (exclusive to KING) can stack up to 30ft. high and take loads of 250 lbs.–10,000 lbs.

Swift, safe and easy to control, the KING SKI-WRACKER is the perfect answer when storage space is at a premium. More and more warehouses and factories are installing this unique equipment to handle plastics, sheet metal, wire, scrap metal or tabulating machines. In the film, motor car and aircraft industries, the SKI-WRACKER has proved indispensable. There's a baby SKI-WRACKER too which is perfect for handling machine tools

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(Covered by British and Foreign Patents)

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TEL: STEVENAGE 440

CLASSIFIED ADVERTISEMENTS

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Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

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There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s, ½-page £48. Full page £90.

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Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisement
Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.**
Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

CARMARTHENSHIRE EDUCATION COMMITTEE

AMMANFORD TECHNICAL COLLEGE

FULL-TIME ASSISTANT MASTER

Applications are invited for the post of Full-time ASSISTANT MASTER for Workshop Practice in Machine Shop Engineering, Bench Fitting and Sheet Metal Work, at the above-named Technical College.

Candidates should possess a Higher National Certificate in Mechanical or Production Engineering and/or a City and Guilds of London Institute qualification in Machine Shop Engineering. A good workshop training and Mining experience will be an added recommendation.

Salary in accordance with the Burnham Further Education Report, 1956, for Grade A Assistants (£475 by £25 to £900). Increments will be allowed for approved training, industrial experience, &c.

Duties to commence on 1st January, 1959.

Forms of application, which must be returned not later than 29th October, 1958, may be obtained from the undersigned on receipt of a stamped, addressed envelope.

IORWERTH HOWELLS,
Director of Education.

County Education Offices,
County Hall,
Carmarthen. E8839

COUNCIL FOR TECHNICAL CO-OPERATION IN SOUTH AND SOUTH-EAST ASIA

UNIVERSITY OF CEYLON

APPOINTMENTS

Applications are invited by the Commonwealth Relations Office for two appointments under the Technical Co-operation Scheme of the Colombo Plan, at the University of Ceylon, as follows :—

(1) PROFESSOR OF MECHANICAL ENGINEERING.
(2) LECTURER IN ELECTRICAL ENGINEERING (ELECTRIC POWER).

Candidates for both posts must have several years' research and University teaching experience. Duration 3 years in the case of the Professor of Mechanical Engineering and 2 to 3 years in the case of the other post. Salary for (1) £2300 per annum, plus tax-free oversea allowance of £1090 per annum (married), or £590 per annum (single), and for (2), £1650 per annum, plus tax-free oversea allowance of £1090 per annum (married), or £590 per annum (single), plus other allowances. Free furnished accommodation provided. Contract with the U.K. Government.

For further information and application forms, write Ministry of Labour and National Service (E.9), 26–28, King Street, London, S.W.1, quoting E.9/TCS/216–7/CEY. E8841

UNIVERSITY OF LONDON KING'S COLLEGE

FACULTY OF ENGINEERING

METALLURGIST

ENGINEER OR PHYSICIST

Applications are invited for appointments as :
(a) METALLURGIST ;
(b) ENGINEER OR PHYSICIST.

A grant from the Nuffield Foundation enables King's College to offer two research posts to Graduates suitably qualified in Metallurgy for (a) and in Physics or Engineering for (b). The research work will be in the field of Biomechanics, which is the application of the principles of engineering science to the practice of surgery and medicine. A well-equipped laboratory for Biomechanics is available.

The emoluments for post (a) will be in the range of £900–£50–£1200, with F.S.S.U. and family allowance, and for post (b) £500–£650. It is intended that the successful candidates should be eligible to read for a higher Degree of the University of London.

Application forms may be obtained from the Registrar, King's College, London, Strand, W.C.2. Completed forms must reach him by October 31st. E8786

PUBLIC APPOINTMENTS

DORSET COUNTY EDUCATION COMMITTEE

POOLE COLLEGE FOR FURTHER EDUCATION

Principal : A. H. ANDREWS, A.R.C.A.

ENGINEERING DEPARTMENT

GRADE B ASSISTANT ENGINEERING INSTRUCTOR

Grade B ASSISTANT ENGINEERING INSTRUCTOR required, to take up duties in January, 1959, to teach two or more of the following : Mathematics, Engineering Drawing, Engineering Science, Workshop Technology and Practice to O.N.C., and City and Guilds Final Certificate level. Qualifications : H.N.C., Degree, or equivalent professional qualification.

Further particulars and forms of application can be obtained from the Principal, Poole College for Further Education, North Road, Parkstone, Poole, Dorset, by whom completed applications should be received within two weeks of the appearance of this advertisement. E8852

NEWCASTLE UPON TYNE EDUCATION COMMITTEE

RUTHERFORD COLLEGE OF TECHNOLOGY

(SELECTED FOR DEVELOPMENT INTO A COLLEGE OF ADVANCED TECHNOLOGY)

LECTURER

Applications are invited for appointment as LECTURER IN MECHANICAL ENGINEERING for Higher National Certificate and Higher National Diploma Courses ; duties to commence on 1st January, 1959. Candidates should hold a good Degree, have had industrial and, preferably, teaching experience. Salary : £1200 by £30 to £1350.

Application forms (returnable within fourteen days) and further particulars may be obtained from the Principal, Rutherford College of Technology, Bath Lane, Newcastle upon Tyne, 1.

H. V. LIGHTFOOT,
Clerk of the Governors.
E8867

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY,

PRINCE CONSORT ROAD, S.W.7

ENGINEER

Applications are invited for the appointment of an ENGINEER on the Development and Maintenance Staff to supervise the installation of heating, ventilating and associated plant in new buildings and to be responsible for its operation and maintenance on completion.

Applicants must hold a Degree in Mechanical Engineering or a Higher National Diploma in Mechanical Engineering ; or a First Class (Steam) Certificate of the M.O.T. Experience in the installation and operation of boiler plant, and of electrical installations will be an advantage.

Salary within the range £1000 to £1300. Permanent, pensionable post. Further particulars from Planning Office, Imperial College of Science and Technology, Prince Consort Road, S.W.7. E8856

UNIVERSITY OF BIRMINGHAM

CHANCE CHAIR OF MECHANICAL ENGINEERING

Applications are invited for the CHANCE CHAIR OF MECHANICAL ENGINEERING and the HEADSHIP OF THE DEPARTMENT OF MECHANICAL ENGINEERING, which will be made vacant by the retirement of Professor G. F. Mucklow on 30th September, 1959.

Applications (three copies), with the names of three referees, should be sent by 30th November, 1958, to the Registrar, The University, Birmingham, 15, from whom further particulars may be obtained. E8868

PUBLIC APPOINTMENTS

SURREY EDUCATION COMMITTEE

KINGSTON TECHNICAL COLLEGE
FASSETT ROAD, KINGSTON-UPON-THAMES

SENIOR LECTURER

Applications are invited for the post of SENIOR LECTURER IN MECHANICAL ENGINEERING, to specialise in Applied Thermodynamics and Internal Combustion Engines.

Candidates should be Honours Graduates in Engineering ; industrial and/or research experience is desirable, and teaching experience is essential.

Duties to commence on 1st January, 1959, or as soon after as possible.

Salary : £1350 by £50 to £1550. London Allowance payable.

Form of application and further particulars from the Principal, on receipt of stamped, addressed envelope, to be returned as soon as possible. E8871

MERSEY RIVER BOARD

ASSISTANT ENGINEER

Applications are invited for the position of ASSISTANT ENGINEER at the Board's Office in Sale, Cheshire.

The salary will be in accordance with Local Government Scales, within the range A.P.T. Grade I to Special Grade (£575–£1030 p.a.), according to qualifications and experience. Candidates should have passed Parts I and II of the Institution of Civil Engineers Examination or hold a University Degree exempting them.

The appointment, which may be terminated by one month's notice on either side, is subject to the Local Government Superannuation Acts and to the passing of a medical examination.

Applications, stating age, education, qualifications and experience, together with the names of two persons to whom reference may be made, should be addressed to J. T. Firth, B.Eng., M.I.C.E., Engineer to the Board, at the address given below, and should be received not later than the 1st November, 1958.

A. H. JOLLIFFE,
Clerk of the Board.

Liverpool Road,
Great Sankey,
Warrington. E8785

WEST MIDLANDS GAS BOARD

INDUSTRIAL DEPARTMENT

SENIOR DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

Candidates should possess the Higher National Certificate in Mechanical Engineering or equivalent qualifications, and have had experience in the design of furnaces and stoves or similar equipment. The duties will include the supervision of a small Drawing Office.

The salary will be within A.P.T. Grade II (£931–£1056 per annum) of the National Salary Scales for Gas Staffs.

The post is pensionable and the successful candidate may be required to pass a medical examination.

Applications, stating age, experience, positions held and qualifications, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15, to reach him not later than the 25th October, 1958. E8863

MINISTRY OF TRANSPORT AND CIVIL AVIATION

LONDON

ASSISTANT RAILWAY EMPLOYMENT INSPECTOR

Pensionable post in London for a man at least 32 on 1st October, 1958, requiring at least 10 years' experience of practical railway service, sound knowledge of British railway operation and maintenance and wide mechanical experience. Ability to write clear and concise reports essential. London salary scale : £1030–£1250.

Write Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S4894/58/12. Closing date, 25th November, 1958. E8866

PUBLIC APPOINTME

UNITED KINGDOM AT ENERGY AUTHORI

INDUSTRIAL GROUP HEAD RISLEY, WARRINGTON, LA

CONSTRUCTION ENGI

The United Kingdom Atomic Ener Industrial Group Headquarters, Risley Lancashire, requires

CIVIL ENGINEERS (Ref. 2704)
MECHANICAL ENGINEERS (
ELECTRICAL ENGINEERS (R

for the Construction Branch which for carrying out a varied programme work on large-scale Atomic Energy bu on sites throughout the country. Su dates will serve on the staff of Resid and will be required to move from necessary.

A recognised engineering appre pupilage, Corporate Membership of Senior Engineering Institution, or e experience of engineering problems large sites are essential.

Salary between £815 (at age 25) and Contributory pension scheme.

Housing at the sites, or assistance expenses on house purchase may be a

Send postcard for application form, priate reference, to Recuitment Offi address.

Closing date : 3rd November, 1958.

WEST MIDLANDS GAS

WOLVERHAMPTON AND DIVISION

DIVISIONAL DRAWING

ENGINEERING DRAUGHT

Vacancy for ENGINEERING MAN, Divisional Drawing Office.

Candidates must possess at least a H Certificate and have had a good engine and experience in engineering dra structural and building work. The capable of carrying out site surveys ; t of drawings, specifications and estim site supervision of large projects.

The successful candidate may be re either at Dudley or at Wolverhampton

The salary for the appointment, wh able and subject to medical examin within Grade A.P.T. 10 (£892–£992 the National Salary Scales for Gas Sta

Applications, stating age and experi with the names of two referees, should to Mr. Stanley Jones, Divisional Gen West Midlands Gas Board, Kensti Bath Street, Dudley, to reach him 25th October, 1958.

J. S
Secretary to
E8862

BRITISH RAILWAYS RES DEPARTMENT

DERBY

SENIOR TECHNICAL ASS

Vacancy for SENIOR TECHNICAL Derby, in group engaged in research structures, mainly bridges of steel concrete construction. Knowledge of and civil engineering experience requir experience, particularly with resistance techniques, an advantage. Professi qualifications desirable.

Salary range : £833 to £985 per an Superannuation and certain free tr Medical examination.

Applications, stating age, qualificati Director of Research,
British Transport Commissio
(British Railways Division),
222, Marylebone Road,
London, N.W.1.

PUBLIC APPOINTMENTS

GHANA PUBLIC SERVICE COMMISSION

GHANA RAILWAY

DEPUTY CHIEF ENGINEER

...ons are invited for the post of DEPUTY ...GINEER, Ghana Railway, to assist ...ager for all Railway and Harbour Works ...ation of all estimates and control of all ...ations of the Civil Engineering Department, ...der the Chief Engineer when on leave. Must ...ld a Chief Engineer when on leave. Must ...(Eng.), or other recognised Engineering ...and have obtained not less than 12 years' ...ical after obtaining Degree, of which not less ...must be on a railway, or passed Parts I ...examination of the I.C.E., with not less ...approved experience after passing, of ...5 years must be on a railway ; and ...organising and administrative ability. ...will be given to Engineers with both ...and Harbour experience. Candidates must ...under 35 years of age. Salary : £2280 by ...£120 a year. Appointment on contract for ...period of 18–24 months' duration. Gratuity ...rate of £12 10s. for each completed month of ...satisfactory service, payable on completion of contract. ...Free passages for officer, wife and up to ...children under 18 years and, in addition, an ...annual allowance for children when not resident ...with parents of £100 a child for up to 3 children under ...certain conditions. Generous home leave on full pay. Income ...tax free. Preservation of superannuation ...rights and local rates. Preservation of superannuation ...benefit rights, where applicable, can be ...arranged.

...Further particulars and application form, ...stating age, qualifications and experience, to ...the Director of Recruitment, Ghana High Commission, 13, Belgrave Square, London, S.W.1. E8849

MINISTRY OF SUPPLY RESEARCH AND DEVELOPMENT ESTABLISHMENTS

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

...ry of Supply Research and Development ...ments, mainly in southern half of England, ...(a) SENIOR SCIENTIFIC OFFICERS ...Age 28), and (b) SCIENTIFIC OFFICERS ...Physics, Electronics, Electrical or ...Engineering, Applied Mathematics, ...Chemistry or Metallurgy. 1st or ...Degree or equivalent required, and ...(a) and 3 years' post-graduate experience. ...Salary range : (a) £1130–£1330 ; (b) ...(men in provinces). Rates for women ...equality in 1961. Superannuation under ...Opportunity for those under 32 to com... ...established posts. Candidates should ...fields of work in which interested. At ...Gas Turbine Establishment, Pyestock, ...houses available for letting to married staff, ...preference for new graduates to have work...

...from M.L.N.S. Technical and Scientific ...(K), 26, King Street, London, S.W.1 (quote ... E8836

GOVERNMENT OF ADEN

PUBLIC WORKS DEPARTMENT

MECHANICAL AND MECHANICAL ENGINEER

...service the Department's workshops and ...plant, including operating, maintenance and ...of civil engineering mechanical plant and ...including refrigeration.

...first appointment. Emoluments £2004 per ...with a gratuity of £37 10s. per quarter on ...satisfactory completion of contract. Furnished ...or refrigerator at low rent. Free medical ...and free passages for the officer, his wife and ...and children under 18. Allowance for educa... ...children outside Aden. Generous home ...leave.

...Candidates should be A.M.I.Mech.E. and have ...more than seven years' training and practical ...experience. An electrical engineering qualification ...or experience with refrigerating equipment will be ...an advantage.

...Director of Recruitment, Colonial Office, ...Great Smith, age, qualifications and experience ...quoting MCD 112/2018. E8854

NORTHERN GAS BOARD

DARLINGTON DIVISION

TECHNICAL ASSISTANT (MECHANICAL)

...Applications are invited for the position of TECH... ...ASSISTANT (MECHANICAL) at the ...Depot. Duties include the maintenance of ...machinery and buildings, and the minimum ...qualification for the post is a Higher National Certifi... ...in Mechanical Engineering or an equivalent ...Institute of Transport qualification. The position ...is open to a sea-going engineer, seeking a ...change.

...Salary A.P.T. 7/8 (£733–£853 per annum), ...commencing according to qualifications and ...experience.

...The successful candidate will be required to pass a ...medical examination and to join the Board's pension ...scheme.

...Applications, stating age, qualifications and expe... ...together with the names of two referees, ...should be addressed to Mr. Charles Hindle, Sub... ...Area Manager, Northern Gas Board, Gas ...Showroom, Street, Darlington, to arrive not later ...than 31st, 1958.

F. WILSON,
Divisional General Manager.

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

DURHAM DIVISION

WORKSHOPS SUPERINTENDENT

Required for the No. 1 Area Central Workshops at Whitburn, near Sunderland.

Salary range : £900 to £1400.

The Works employ about 200 personnel and are engaged mainly upon the overhaul and reconditioning of mining machinery, together with the development and construction of special equipment and plant. The works have an overhaul and reconditioning shop for mining machinery ; plating, construction, blacksmith and heat treatment shops ; machine, electrical and carpenter's shops.

Applicants should have an approved engineering background and comprehensive experience of modern management, planning and production control techniques, and should hold a Higher National Certificate or its equivalent in Mechanical or Production Engineering, with an Electrical Endorsement.

Apply within 7 days, quoting 1070/78 and giving details of age, education, qualifications and experience to : No. 1 Area Staff Manager, National Coal Board, Durham Division, Station Road, South Shields. E8864

MINISTRY OF LABOUR AND NATIONAL SERVICE

ROYAL NAVAL SCIENTIFIC SERVICE

APPOINTMENTS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole, Greenock and Rosyth. Main requirements are about 25 vacancies for PHYSICISTS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist : MECHANICAL ENGINEER, for work on gas turbine problems in the London area. MECHANICAL ENGINEER, for work on design and development of U/W devices in Portland area. METALLURGISTS for Rosyth and Poole. CHEMISTS (Physical and Inorganic), for Poole area, Baldock and London. Candidates must normally be natural born British subjects of natural born British parents, with at least First or Second Class Honours Degrees or equivalent high professional attainments. S.S.O.'s must have had at least three years' post-graduate experience and be not less than 26 years of age. Salaries : (men) S.S.O. £1190–£1410 ; S.O. £635–£1110 (London)—somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A98/8A. E8879

FOREIGN OFFICE

UNITED KINGDOM OF LIBYA

PORT ENGINEER

Applications are invited for post of PORT ENGINEER under the Provincial Government of Tripolitania.

Qualifications : A.M.I.C.E. Experience in construction of ports and jetties.

Salary : £1800 per annum, not liable to United Kingdom Income Tax (Schedule E). Local tax 8 per cent of salary. Provident Fund, to which the employer and employee both contribute 7½ per cent salary, is paid at end of contract. Initial contract two years. Home leave of 72 days each two years. Free passages by air for official and family.

Applications, in writing, to Room 140, Foreign Office, London, S.W.1. E8877

BEXHILL CORPORATION

WATER UNDERTAKING

ENGINEERING ASSISTANT

Appointment to be made within Special Grade, £750 to £1030.

Applications are invited for the above appointment from suitably qualified persons, and " Forms of Application " may be obtained from the Water Engineer and Manager, Town Hall, Bexhill-on-Sea.

The appointment is subject to :

(1) National Scheme of Conditions of Service.

(2) The Local Governments Superannuation Acts, and

(3) A satisfactory medical examination.

Closing date for receipt of applications October 31st, 1958.

EDWARD SMITH,
Town Clerk.
E8837

CIVIL SERVICE COMMISSION

CIVIL ENGINEERS

Pensionable posts for men and women aged 25 and under 35 on 1st January, 1958 ; extension for regular Forces service, Overseas civil service, established civil service, and temporary Government service as CIVIL ENGINEER. Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining Corporate Membership. Men's starting salary from £755 to £1085. Maximum (London) £1250. Promotion prospects.

Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S64/58. E8865

PUBLIC APPOINTMENTS

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

HYDRAULICS RESEARCH STATION, WALLINGFORD, BERKS.

ASSISTANT EXPERIMENTAL OFFICERS OR EXPERIMENTAL OFFICERS

D.S.I.R. Hydraulics Research Station, Wallingford, Berks., requires ASSISTANT EXPERIMENTAL OFFICERS or EXPERIMENTAL OFFICERS, for work on scale models of hydraulic projects in the civil engineering field.

Qualifications : G.C.E. " A " level in 2 science or maths. subjects or equivalent. Over age 22, Pass Degree, H.N.C. or equivalent generally expected. Experience of engineering drawing and/or constructional work an advantage for some posts.

Salary ranges : Men A.E.O. £370 (over 18) to £645 (26) to £800. E.O. £920–£1130. Women slightly less.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting E.316/8A. Closing date : 7th November, 1958. E8878

DRAUGHTSMEN

Experienced DRAUGHTSMEN, with apprenticeship or workshop experience, and O.N.C. or an equivalent qualification, are required at the U.K.A.E.A., Engineering Unit, Bracknell, Berks, for a wide variety of mechanical, electro-mechanical and electronic work.

Salary scale £555–£865.

Housing and superannuation schemes.

Send POST CARD to the Group Recruitment Officer (1201/25), A.E.R.E., Harwell, Berks, for application form and details.

E8823

TENDERS

BISHOP'S STORTFORD URBAN DISTRICT COUNCIL

SEWERAGE

CONTRACT NO. 2A

TENDERS are invited on a fixed price basis in accordance with the Ministry of Housing and Local Government Circular No. 31/57, for the CONSTRUCTION of SEWERAGE and a SEWAGE PUMPING STATION at Bishop's Stortford.

The sewerage will consist of approximately 1300 linear yards of 21in. to 36in. diameter concrete pipe sewer, together with precast concrete manholes, and will include a river crossing.

The sewage pumping station will have a reinforced concrete substructure inside a steel sheet piled cofferdam approximately 25ft. deep, and a prefabricated superstructure.

General conditions of contract, specification, bills of quantities and drawings may be obtained from the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, S.W.1, on and after 20th October, 1958, on payment of a deposit of ten guineas, refundable only to contractors who submit bona fide Tenders and return all documents and drawings on or before the last day for receipt of Tenders. Deposit cheques should be made payable to J. D. and D. M. Watson or order.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders must be returned in envelopes which do not bear any name or mark indicating the sender, endorsed " Tender for Contract No. 2A," and delivered at the office of the undersigned by noon on 22nd November, 1958.

G. NORMAN DRINKWATER,
Clerk of the Council.
Bishop's Stortford Urban District Council,
The Council House,
Bishop's Stortford, Herts. E8876

STATE ELECTRICITY COMMISSION OF VICTORIA

22, WILLIAM STREET,
MELBOURNE, VICTORIA, AUSTRALIA

DESIGN, MANUFACTURE AND ERECTION OF SPILLWAY GATES

The Commission is inviting TENDERS for the DESIGN, MANUFACTURE and ERECTION of SPILLWAY GATES at Yallourn Storage Dam, Yallourn Power Station, in accordance with Specification No. 58–59/47.

Full particulars are available from the Agent-General for Victoria, Victoria House, Melbourne Place, Strand, London, W.C.2.

Tenders, endorsed " Tender to Specification No. 58–59/47," are returnable direct to the above address at or before 11 a.m. on 24th December, 1958.

The Commission does not bind itself to accept the lowest or any Tender. E8830

EDUCATIONAL

UNIVERSITY OF LONDON

A LECTURE entitled " Some Automata of the Eighteenth Century " (with numerous coloured-slide illustrations) will be delivered by Dr. H. Zemanek (Vienna) at 5.30 p.m. on 28th October at the Royal College of Science (Main Chemistry Theatre), Imperial College of Science and Technology, Imperial Institute Road, S.W.7. ADMISSION FREE, WITHOUT TICKET.

JAMES HENDERSON,
Academic Registrar.
E8819 E

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E., A.M.I.Chem.E., A.M.I.M.I., A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8.
E102 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A BRITISH-MANAGED ENGINEERING GROUP with works in Bihar, India, requires for its Head Office Administrative Staff in Calcutta a GRADUATE ENGINEER (preferably single) in the age group 26–32 who is interested in making a career in India. Candidates who have had training in steel works or at a refractory works would be preferred and subsequent sales experience would be advantageous.—Applicants should state age, experience and whether married or single.—Write Box SE/124 c/o 95, Bishopsgate, London, E.C.2.
E8756 A

A.E.I.–JOHN THOMPSON NUCLEAR ENERGY COMPANY, LTD., RADBROKE HALL, KNUTSFORD, CHESHIRE

GRADUATE MECHANICAL ENGINEERS

Applications are invited from GRADUATE MECHANICAL ENGINEERS for work connected with the assessment of the safety and operating characteristics of nuclear power plants.

Previous experience of general industrial practice or research is essential. Applicants must have a good mathematical background together with an interest in thermodynamics and fluid flow theory. Special qualifications in mathematics will be looked for but need not be essential.

The offices are situated in Knutsford and the Company provides transport from the Stretford/Sale/Altrincham areas and there are first class dining facilities. This position is on the permanent staff and there is a contributory pension scheme in operation.—Application should be made to the Chief Engineer, quoting reference JRMS/JMY.

E8797 A

AN ADDITIONAL DESIGNER DRAUGHTSMAN REQUIRED, for small City office, mainly concerned with coal handling plant for modernising retail depots. What is wanted is someone who can extend considerable experience gained by company in this field.—Apply in writing to Charrold, Ltd., 40, Trinity Square, London, E.C.3. E2139 A

A WELL KNOWN INDUSTRIAL ORGANISATION

wishes to recruit a

MECHANICAL ENGINEER

not necessarily fully qualified, who could be responsible for the installation and maintenance of small plants of a continuous process nature in customers' premises. He would be a member of a management team and would be responsible for all projects within his area. An attractive salary is offered which will not be below £1000. —Write stating full details to BOX No. E8829, " The Engineer."

CEMENT MANUFACTURERS REQUIRE AN ENGINEER to assist in the mechanical and, if possible, civil work associated with the planning for and installation of a very wide range of new plant. The position, which calls for a man of about 30, with initiative, who has had considerable experience of site work, offers distinct possibilities of advancement. Bonus and pension schemes.—Applications, giving age, qualifications, training and experience, should be addressed to : The Area Engineer, A.P.C.M., LTD., Stone Castle, Greenhithe, Kent. E8818 A

Classified Advts. continued on page 118

SITUATIONS VACANT

CHIEF DRAUGHTSMAN.—Applications are invited for a responsible man to take charge of a small Chemical Engineering Drawing Office in London. Diplomatic handling of staff with considerable experience in the design and layout of chemical plant are essential. Minimum qualifications H.N.C. The position is pensionable and the salary will be commensurate with experience and ability. Full particulars.—BOX No. E8880, "The Engineer." A

CHEMICAL ENGINEER

required by

The Chemicals Division of the British Oxygen Company, Limited

for an interesting new position. Experience is essential in large-scale production, preferably in the heavy organic field, with some background of costing and development work. Headquarters will be situated in London. The desirable age range will be 30–35 years. This is a progressive and pensionable position and a good salary appropriate to the age, qualifications and experience of the successful candidate will be paid. Apply in writing to :

The Staff Officer,
THE BRITISH OXYGEN CO., LTD.,
Bridgewater House,
Cleveland Row, St. James's, S.W.1.

E8822 A

DRAUGHTSMEN required by Consultants in Victoria area. Fully experienced in heating or ventilating work. High standards essential and experience in a consultants' office desirable. Salaries up to £1100, according to experience and qualifications.—A. F. MYERS & PARTNERS, 147, Victoria Street, London, S.W.1. E2135 A

DRAUGHTSMEN.—Senior Engineering Draughtsmen required in our works plant engineering and maintenance department. Applicants, aged 28 or over, should hold H.N.C. or equivalent in one of the following :—

Mechanical.
Electrical.
Building.

Apprenticeship and 5 years' subsequent workshop experience desirable, plus originality and flare for design.—Write in confidence, with full details, to Siemens Edison Swan, Ltd., Ref. 744/33, Woolwich, London, S.E.18. E8857 A

DESIGNER DRAUGHTSMAN urgently required for interesting work in connection with special crane type structures, hoisting machinery (steam, diesel, electric) and contractors' plant. Candidates should have a H.N.C. in Mechanical Engineering, be at least 28 years of age, and capable of accepting responsibility for complete projects. Contributory pension scheme, canteen facilities and convenient transport.—Apply in writing, giving full particulars of age, experience, qualifications and salary required, to the Personnel Officer, The British Steel Piling Co., Ltd., Claydon, Suffolk. E8873 A

EDITORIAL POST. YOUNG ENGINEER qualified to become corporate member major engineering institution required to fill editorial post covering light electrical and electronic engineering. Desire to write essential. Age 26 to 30 preferred. Pension and Bonus Schemes. Reply, stating age, particulars of qualifications and experience to date, to : The Editor, "The Engineer," 28, Essex Street, London, W.C.2. E8825 A

ENGINEER REPRESENTATIVE
LONDON

An old-established Midlands firm of Structural Engineers requires an ENGINEER to represent them in London and the South.

Qualifications : age 35 to 38, experience in Structural Engineering, able to conduct negotiations, preferably a member of the Institution of Civil or of Structural Engineers, of good personality and address and possessing initiative.

Office accommodation would be provided together with a salary appropriate to the requirements of the post.

Applicants are invited to write, in confidence, to the Managing Director, the LILLESHALL COMPANY, LTD., St. Georges, Oakengates, Shropshire.

E8805 A

ENGINEERING INSURANCE. Applications are invited from Mechanical Engineers not over 35 years of age, who having served an apprenticeship with Crane and Lift Makers have a sound theoretical and practical knowledge of Cranes, Lifts, Lifting Machines and their maintenance, and are qualified to Higher National Certificate standard, for a vacancy as ENGINEER SURVEYOR in the West Country. The position is permanent, pensionable, with salary scale of £735 rising to £1060 per annum, plus expenses and allowances.—Apply in own handwriting to BOX No. E8776, "The Engineer." A

FACTORY ENGINEER

required by an international food manufacturing Group for one of their South American meat packing factories.

Applicants should have indentured apprenticeship or membership of an engineering society, with experience of factory engineering administration, plant maintenance, costing, boilers and other pressure vessels, oil firing, electrical generating machines, diesels, refrigeration, distribution of general services, general construction work and spares provisioning.

Knowledge of Spanish an advantage and good health essential. Age about 35. Scope exists for transfer within the Group. Home leave. Good salary. House provided.

Write, with full particulars, to the Secretary, Liebig's Extract of Meat Co., Ltd., Thames House, Queen Street Place, London, E.C.4.

E8861 A

FIRST-CLASS DESIGNER REQUIRED for shot-blasting machinery. Good salary and excellent prospects for the right man.—Write BOX 352, Dorland Advertising, Ltd., 18-20, Regent Street, S.W.1. E8777 A

FIRST-CLASS ENGINEER required immediately to train and take charge, in early 1960, of member firm of large group, employing approximately 150 personnel engaged in manufacture of winding, hauling and steel works plant. Excellent opportunity for applicant having skilled engineering training with a flair for commercial and general administration ; age 35/40. Write, giving fullest details respecting qualifications, experience, age and salary required.—BOX No. E2113, "The Engineer." A

GOSS PRINTING PRESS COMPANY LIMITED have an immediate vacancy for a SENIOR DRAUGHTSMAN with experience in the design of machine tools. This is a permanent position with a generous superannuation scheme and a bonus is paid annually. Salary paid will be in accordance with ability and experience.—Please supply full details of age, experience and qualifications, to Personnel Manager, Greenbank Street, Preston. E8875 A

HEATING AND VENTILATING ENGINEERS required by consultants in Victoria area. Capable of accepting design responsibility for large projects and preferably with consulting experience. Salaries up to £1500, according to experience and qualifications.—A. F. MYERS & PARTNERS, 147, Victoria Street, London, S.W.1. E2134 A

JOHN SMITH'S TADCASTER BREWERY COMPANY, LTD., The Brewery, Tadcaster, Yorkshire, require a FIRST ASSISTANT to the Chief Engineer. Applicants should be of University degree or recognised institution standard in mechanical engineering. Age not exceeding 35 years. Attractive commencing salary and pension scheme. House available if required.—Applications stating age, married or single, experience and qualifications to be addressed to the Engineering Director. E8806 A

LADY TRACER required for work in Westminster area by professional firm. Civil engineering experience advantageous, but neatness and speed more important. Salary will be considered in relation to experience.—BOX No. E8831, "The Engineer." A

LONDON ENGINEERING FIRM, representing leading German Mechanical and Electrical Manufacturers (including Traction and Marine), requires TECHNICAL SALES ENGINEER. The position offers good prospects for young engineer with imagination and initiative. Knowledge German language desirable.—BOX No. E2138, "The Engineer." A

LUBRICATION ENGINEER required by lubrication equipment engineers. Location London, N.18. Lubrication knowledge an advantage, but not essential if good practical and technical background. Excellent prospects. Apply in confidence.—BOX No. E2127, "The Engineer." A

MAINTENANCE ENGINEER/FITTER required, with good working knowledge of motor vehicles. Age between 30 and 40. Good reference. Good salary.—Apply : Wendell Park Products, Ltd., 20, Wendell Road, Shepherds Bush, W.12. E2137 A

MANAGER
for
ENGINEERING COMPANY

Applications are invited for a position as GENERAL MANAGER of a light engineering works in Glasgow. Total employees—staff and operatives—about 150.

Applicants should have served an apprenticeship in mechanical engineering, and hold a degree or equivalent qualification. They should have practical experience of modern machine tools and production methods, combined with some commercial experience, which might include costing, stock control, sales.

Non-contributory pension scheme.

Applications, in strict confidence to BOX No. E8843, "The Engineer."

A

MUNICIPAL MUTUAL INSURANCE, LTD., has vacancies for ENGINEER SURVEYORS in Birmingham and London. Posts are pensionable and permanent to satisfactory candidates who should have served an apprenticeship and have sound practical and theoretical knowledge. Technical qualifications : First Class Ministry of Transport Certificate. Salary : £735–£1060 per annum.—Apply in own handwriting, marking the envelope "Application : Engineer Surveyor" and "Private and Confidential," to CHIEF ENGINEER, 22, Old Queen Street, Westminster, S.W.1. E8858 A

OLD-ESTABLISHED FIRM of Mechanical Engineers in the West of England engaged on all types of heavy mechanical handling plant and constantly expanding, require qualified MECHANICAL ENGINEERS able to take charge of Contracts in the Drawing Office. Superannuation scheme and good canteen facilities are available.—Please write in the first instance, giving full particulars of qualifications, experience, level of remuneration desired to : The Chief Draughtsman, STRACHAN AND HENSHAW, LTD., Victoria Road, St. Philip's, Bristol, 2. E2120 A

REORGANISATION OF TECHNICAL SALES requires the appointment of a SALES REPRESENTATIVE with first-class technical knowledge and considerable experience in the selling of heavy Marine Diesel Engines.—Write giving all details, age and salary required, to BOX No. E8743, "The Engineer." A

SENIOR DESIGN DRAUGHTSMAN required by development department of large light alloy manufacturing organisation in the West London area. Knowledge of light alloys an advantage, salary commensurate with qualifications and experience, contributory pension scheme in operation.—Write, giving full details, to BOX No. E8859, "The Engineer." A

SENIOR SALESMAN required by precision engineering company in the Midlands area manufacturing hydraulic equipment and small component parts for machine tool and allied trades. Good education essential. Contributory pension scheme available. Apply in writing, giving full details of training, experience and salary required.—BOX No. E2112, "The Engineer." A

SENIOR SERVICES DRAUGHTSMAN required with experience of Factory services for water, gas, oil and air ; pump installations and pipe layouts.—Write or telephone to Chief Draughtsman, General Engineering Dept., Northern Aluminium Company, Ltd., Rogerstone, Mon. Telephone : Newport 59991/6. E8814 A

STRUCTURAL STEEL DETAIL DRAUGHTSMAN, East Yorkshire. Help can be given in obtaining accommodation. Varied work, pensionable post. Give details of age, experience and salary to BOX No. E8833, "The Engineer." A

THE BRITISH STEEL PILING CO., LTD., requires two TECHNICAL SALES REPRESENTATIVES.

1. FOR SCOTLAND. Applicants should be aged 30 to 40, resident or willing to become resident in Scotland, preferably with technical sales experience among civil engineering contractors, consulting engineers and public authorities. The successful applicant will have to undergo two or three months' training before commencing his duties at the beginning of 1959. Remuneration after the probationary training period will be by salary and commission. A car will be provided and travelling expenses paid. The position is permanent and pensionable—Applications should state age, experience and availability, marking the envelope "Scottish Representative."

2. FOR THE CENTRAL LONDON AREA. Applicants should be aged about 30 to 45 with civil or mechanical engineering training, preferably with technical sales experience among civil engineering contractors and consulting engineers. Good appearance and an ability to conduct discussions with the Company's customers are essential. The successful applicant will be required to undergo two or three months' training before commencing his duties. Remuneration will be by salary, depending on the applicant's qualifications, with an annual bonus at the Company's discretion. The position is permanent and pensionable.—Applications should give an indication of the salary required and state age and previous experience, marking the envelope "London Representative."

Applications will be treated in strict confidence and should be in writing only, addressed to the Company at 10, Haymarket, London, S.W.1. E8832 A

THE INSTITUTION OF STRUCTURAL ENGINEERS
APPOINTMENT OF DEPUTY SECRETARY

Applications are invited for the appointment of DEPUTY SECRETARY of the Institution of Structural Engineers at their Headquarters in London, with a view to eventual appointment as Secretary.

Applicants should preferably be corporate members of a Chartered Engineering Institution, have appropriate administrative experience and be between the age of 35 and 50.

The commencing salary will be from £1800 to £2000 per annum according to experience.

The closing date for the receipt of applications is the 24th October, 1958.

For further details apply to the Secretary of the Institution, 11, Upper Belgrave Street, London, S.W.1, the envelope to be marked "Deputy Secretary." E8451 A

THE GLACIER METAL CO., LTD.

invites applications for the post of SERVICE STATION ENGINEER. The person appointed will work as a member of the Company's Technical Division attached to the Manager of it's Glasgow Service Station—a self-contained unit engaged on the specialised production and repair of bearings. The Station Engineer will be responsible for ensuring that high production standards are maintained in the station, must continually investigate areas of production where changes in methods, layout or machinery could lead to increased efficiency, and propose and assist in implementing such changes. Applicants should have had some experience of design work and have served an Engineering Apprenticeship. A knowledge of estimating, plant layout, material handling and work study would be useful. Academic qualifications to the standard of Corporate Membership of I.Mech.E. or I.Prod.E. are desirable. The post presents a good opportunity for a Young Engineer wishing to enter management. Preferred AGE RANGE 25–35 but candidates outside this will be considered. SALARY RANGE £900–£1300 per annum.

Applications should be sent to the Personnel Director, Ref. G.S.E., Glacier Metal Co., Ltd., Ealing Road, Alperton, Wembley, Middlesex. E8870 A

THE MAKERS OF HOLLANDS TOFFEE require a DRAUGHTSMAN (MECHANICAL), aged 25–40. Qualifications must include apprenticeship and preferably H.N.C. Workshop experience desirable, coupled with knowledge of machine design and mechanical handling. Experience of confectionery machinery manufacture an advantage. Salary according to qualifications and experience. Non-contributory Pension Scheme.—Full details in own handwriting to Personnel Manager, Arthur Holland, Southport, Lancs. E8828 A

TO MEET AN EXPANDING PROGRAMME of development, a large organisation with Headquarters near London urgently needs more DRAUGHTSMEN. Experience in process plant is required in some of the work, but MECHANICAL DRAUGHTSMEN are also needed since the programme includes development work in novel processes essentially mechanical in nature. There are vacancies also for men with plant instrumentation knowledge. Good starting salaries will be paid and pension and profit-sharing schemes are in operation. Mortgage facilities are available and some help towards cost of removal.—Apply briefly to BOX No. E8642, "The Engineer," quoting Ref. D.I. A

WANTED FOR A GROUP OF THREE LONDON STRUCTURAL STEEL COMPANIES, the services of a first-class EXECUTIVE REPRESENTATIVE, well-experienced in securing and organising structural contracts. Apply with full particulars in strictest confidence (guaranteed) to the Chairman.—BOX No. E2133, "The Engineer." A

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ESTIMATING ENGINE

An experienced Estim... Engineer is required to joi... development department of a ... works in the Midlands. He ... required to build up detailed ... mates, to check continuously ... watch expenditures.

Wide experience of estimat... heavy mechanical, electrical ... civil engineering is the ess... qualification ; a good knowle... cost and financial accou... would be an additional recom... ation.

Housing prospects in the ar... good.

Write with full details to ... No. E8847, "The Engineer."

BICC

British Insulated Callender's C... tion Co., Ltd., carrying out importa... way Electrification contracts in co... with the Transport Commission's ... modernisation programme, requi... tional Design Staff at their Traction ... ment Headquarters, Kirkby, Nr. Li... namely :

STRUCTURAL ENGINE... DESIGNERS
DRAUGHTSMEN

The work is varied and interesting, ... ing the design of foundations and s... carrying overhead wiring. Appo... are intended for the Company's pe... staff ; prospects are good and sal... be generously assessed according ... qualifications and experience.

Applications should be addressed to

The Works Personnel Office...
Ref. C.355,
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Prescot, Lancs.

CARBIDE INDUSTRIES LIMI...

A unit of

THE CHEMICALS DIVISION OF ... BRITISH OXYGEN GROUP ... COMPANIES.

invite applications for the positio...

CHIEF ENGINEE...

at their factory which is under co... at Londonderry, Northern Ireland. ... factory will produce Carbide and ... and is adjacent to the Du Pont factory ... will produce Neoprene.

The Chief Engineer will be respon...

(a) Maintenance of all plant.
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Applicants should have an Honou... in Engineering and be Corporate M... one or more of the professional ... Experience in the Chemical, Petr... similar process industries is essen... 35/45.

This is an interesting, progressive ... offering excellent prospects to a ma... ing the necessary ability, enthusi... energy.

The salary will be appropriate t... cations, age, experience and the ... sibilities involved. There is a ... pension scheme and assistance will ... towards housing and removal expe...

Apply in writing to :—

Staff Officer,
THE BRITISH OXYGEN CO... LTD.,
Bridgewater House, Cleveland ...
St. James's, London, S.W.1.

SITUATIONS VACANT

GLISH ELECTRIC

PATENT DEPARTMENT

English Electric Company requires a qualified electrical engineer for its Department in London. This is a good opportunity for a man wishing to make a career in patent work; the one selected will have the opportunity to train to become a Chartered Patent Agent, and can be expected to sit in due course the examinations for that purpose.

Applicants should have served a graduate apprenticeship in electrical engineering or have equivalent experience, and should not be liable for National Service.

If you feel that this post is of interest to you please write with details of your career and experience to: Dept. C.P.S., Marconi House, 336/7, The Strand, W.C.2, quoting reference B 591D.

E8835 A

SITUATIONS VACANT

RESIDENT ENGINEER

required to supervise the construction of welded oil storage tanks on large-scale projects in Wales and the south of England. Duties will include organisation and supervision of direct labour. This is a senior appointment and applicants must have been previously employed in a similar capacity on such work. Position incorporates non-Contributory Pension Scheme.—Apply stating age, qualifications and previous experience to The Erection Manager, Wm. Neill and Son (St. Helens), Ltd., 38, Victoria Street, Westminster, London, S.W.1.

E8855 A

SITUATIONS VACANT

WILKENS & DEVEREUX (PURCHASING) LTD.

require a

RESEARCH METALLURGIST

for a large, old-established American mining concern in Cyprus. Applicants must be Graduated Metallurgists in ore dressing. Should have a few years' experience in laboratory research on flotation and gravity treatment of sulphide ores and allied problems. Should not be inclined to research only but also be interested in practical mill operation. Must possess some capacity for supervision and attention to detail. Age 30–45 years. Attractive salary. Free furnished house, pension scheme, three years' agreement, with free travel at commencement and termination of contracts. Only top grade men with wide experience need apply. Applications, with copies only of testimonials, to be sent to:—

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11, Waterloo Place, London, S.W.1.

E8874 A

SENIOR PROJECT ENGINEERS

BRITISH OXYGEN ENGINEERING LIMITED

Applications are invited from qualified and experienced engineers for posts as Senior Project Engineers, entailing responsibility for the planning and co-ordination of the design, manufacture and site construction of large-scale chemical plant and other engineering projects, including mechanical, electrical and civil engineering phases. Previous experience in this field and organising and administration ability is required.

Excellent salaries and conditions of service are offered and assistance with house purchase and removal expenses can be offered to successful candidates who will need to move their homes.

Applications should be made in writing to:—

The Personnel Manager (GH/21),
BRITISH OXYGEN ENGINEERING LIMITED
Angel Road, Edmonton, London, N.18.

E8848 A

A CIVIL ENGINEER

is required for a senior and responsible post in connection with a large development programme at a major works in the Midlands. This programme will take several years to complete.

Extensive civil engineering design experience is essential, and must include a wide knowledge of survey and of heavy foundation work.

Applications will be treated as confidential and should give full details of qualifications and experience.

Write BOX No. E8775, "The Engineer." A

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VACANCY

for

GENERAL MANAGER

(labour force about 5,000)

with EXPERIENCE of
COMMERCIAL MANAGEMENT
and LABOUR CONTROL
and BACKGROUND OF
SHIP BUILDING, SHIP REPAIRING
and MARINE ENGINEERING

Age between 45 and 55. Salary £3,000 p.a. and bonus dependent on Company's Annual dividend paid.

Seat on Board after 2 years' satisfactory service.

(No disclosures to third parties without applicant's permission.)

Apply to: BOX No. E2132, "The Engineer." A

THE DISTILLERS COMPANY LIMITED

TECHNICAL MANAGER

The Company has a vacancy for a TECHNICAL MANAGER at the Kenfig, Glamorgan, factory of the Chemical Division, where calcium carbide is manufactured in bulk. Candidates, aged not over 45, must hold a degree in metallurgy or fuel technology, or an equivalent qualification, and should have experience of electric furnaces or rotary kilns; familiarity with refractories and solids handling equipment would be an advantage.

The Technical Manager will take charge of a small department consisting of graduates and technical assistants responsible for the investigation of technical problems arising in the manufacture of calcium carbide; these are mainly metallurgical, or relating to fuel usage. In addition some short-term development work is undertaken.

Salary according to qualifications and experience; non-contributory pension scheme.

Write:
STAFF MANAGER,
THE DISTILLERS COMPANY, LIMITED,
21, ST. JAMES'S SQUARE,
LONDON, S.W.1.
Quote: Ref. 77/58 E

E8851 A

ELECTRICAL ENGINEER

INITIAL SALARY UP TO £2000 PER ANNUM will be paid to the man who can satisfy us that he has the following qualifications, experience and the ability to cope with the responsibilities attached to this important position.

Preferably an Honours degree in Engineering (Electrical) alternatively—

Membership of the Institution of Electrical Engineers.

All-round electrical engineering experience is essential coupled with considerable knowledge of developments in modern electronic techniques.

The capacity to lead and supervise staff responsible for all the electrical designs as applied to the Company's products in the field of measuring and handling operations.

Liaison with sub-contractors supplying bought-out components, and with our own customers in respect of electrical design features of special products.

This is a progressive appointment of considerable scope offering a first-class opportunity to a man of 30/40 years of age and of good standing.

The Company is situated in the Midlands.

Those wishing to apply should write giving full details of age, experience and qualifications to Box No. E8838, "The Engineer."

A

SITUATIONS WANTED

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AGENCIES

MANUFACTURERS seeking to increase their sales in Scotland may secure reliable agents by writing with particulars to the Secretaries of the Scottish Association of Manufacturers' Agents who will advertise under a box number, in the Association News Letter.—Write to Dept. E., Hourston MacFarlane and Co., 5, St. Vincent Place, Glasgow, C.1. E127 D

AGENTS AND SUB-AGENTS required immediately by well-known Building and Civil Engineering Contractors to supervise newly acquired contracts mainly in the North. Qualified men preferred but others of proved ability will be considered. Candidates must have considerable experience with contracting organisations in similar capacity and be reasonably mobile. Salary in accordance with qualifications and experience.—Applications, stating age, training, experience, etc., and quoting post for which applying, should be forwarded to BOX No. E8842, "The Engineer." D

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CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved.—Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

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THE PROPRIETOR of British Patents Nos. 732,474 and 733,121, entitled "METAL RECUPERATOR STRUCTURES FOR INDUSTRIAL HEATING FURNACES" and "RECUPERATOR STRUCTURES FOR INDUSTRIAL FURNACES," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E, Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E8834 H

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Consistently prosperous, thirty-years-old private limited company; engineers, mill furnishers, works suppliers, tool dealers, &c., in N. Midlands, busy industrial area. Sale as going concern. Age and health reasons.—BOX No. E8860, "The Engineer." L

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One 25/30-ton E.O.T. Crane, 50–60ft. span.
One 50/60-ton E.O.T. Crane, 50–60ft. span.
Both the above to be suitable for operation on 400V, 3-phase, 50 cy. supply.—Full details, prices, &c., to BOX No. E8766, "The Engineer." P

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UNUSED 15-ton Sir Wm. Arrol E.O.T. Crane, 51ft 10¾in. span, cab control, 3-motor type, 400 volts, 3-phase, 50 cycles, 21ft. 6in. height of lift,
Available for immediate delivery at very attractive price.
G. E. SIMM (MACHINERY), LIMITED,
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E8798 G

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Four—16in. Steam Locomotives of Stephenson make built 1937 and 1938 with last major overhauls of locomotive and boiler 1953 and 1954.—Interested parties please apply by letter to reference P/EB, Appleby-Frodingham Steel Co., Scunthorpe. E8840 G

Classified Advts. continued on page 120

FOR SALE

600

3000kW 6600 volts 3-phase 50 cycles METROPOLITAN-VICKERS Pass-Out/Condensing Steam Turbo Alternator Set, date 1948, designed for 340 p.s.i.g. initially, 600 deg. F. temperature, also suitable for the following duties :

Output kW	Pass-Out/lb/hour	lb pressure
3000	60,000	40
1800	40,000	110
	double P/out at 1000 kW fully condensing	110 and 40

2500 kW 440 volts 3-phase 50 cycles B.T.H., speed 3000 r.p.m., 250 p.s.i.g. 630 deg. F., steam consumption approx. 12·8 lb/kW/hr. with surface condenser, circulating pumps, &c. Turbine also suitable for pass-out pressures varying between 18/35 p.s.i.

2000 kW 2350 kVA, 6600 or 3300 volts 3-phase 50 cycles BELLISS & MORCOM, 3000 r.p.m., 150/250 p.s.i.g., 530 deg. F. ; with surface condenser and accessories.

1500kW 3300 volts 3-phase 50 cycles by BELLISS & MORCOM, geared set 140/180 p.s.i., 500 deg. F., with jet condenser and accessories.

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E226 G

TWW

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100 TONS NEW SLIGHTLY DEFECTIVE B.H. Rails, 95 lbs. yard, chiefly 60ft.
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400 TONS GOOD SECOND-HAND B.H. RAILS, 80/85 lbs. yard B.S. Section, chiefly 60ft.
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200 TONS SECOND-HAND F.B. RAILS, about 60 lbs. yard, 24ft., 27ft. and 30ft. chiefly.
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WARD'S ALSO HAVE LARGE STOCKS OF ALL CLASSES OF OTHER RAILWAY MATERIALS

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E8826 G

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Adamson, standard cab control, 42ft. 3in. span, 400/3/50.
40-ton Clyde, 42ft. 3in. span, with 20-ton aux., unused.
30-ton Adamson, 42ft. 3in. span, 5-ton aux. ; new in cases.
30-ton Vaughan, 42ft. 3in. span, almost new.
20-ton Vaughan, 42ft. 3in. span, 6-ton aux., 17ft. lift, six available.
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10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.
Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices.

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LTD., COLEFORD, GLOS.
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USED HERBERT MORRIS OVERHEAD, MANUAL - OPERATED, TRAVELLING CRANE, 30 cwt. capacity, 10ft. 6in. span (RSJ), 15ft. lift. In good working order. £125.0.0.—Apply, Bye Pass Motors, Kingston By-Pass, Tolworth, Surbiton, Surrey. Tel.: Derwent 1122. E8869 G

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Edwards

JAMES BENNIE Triple Geared, Open Fronted, Eccentric Punching Press, pressure exerted approximately 255 tons, stroke 3½in., table 3ft. 9in. by 2ft. 6in., hole in bed 25in. by 19in., arranged motor drive for 440/3/50, weight approximately 16 tons 8 cwt.

RHODES Motorised Double Geared Press Brake, with cast iron side frames, reinforced by nickel-chrome steel bars, bed and top beam are of steel plate, arranged motor drive for 400/3/50, pressure exerted approximately 150 tons, forming capacity 10ft. by ⅜in. or 18ft. by approximately ¼in., clear width between housings 10ft. 2in., overall length of bed 18ft. 1in., length of stroke 5in., weight approximately 20 tons.

BESCO High Speed Open End Guillotine Shearing Machine, Undercrank type, arranged motor drive for 400/440/3/50, fitted with automatic sheet hold-down and complete with all gauges, capacity, mild steel, 48½in. by 14 S.W.G. Weight approximately 19 cwt.

New STOELTING Motorised Plate Bending Roller, Pyramid type, with separate motor drive to top pressure roll, arranged motor drive for 400/440/3/50, capacity 10ft. by ¼in., length of rolls 2⅛in., diameter of top roll 9⅝in., diameter of bottom rolls 7 11/16in., rolling speed approximately 16 f.p.m., weight approximately 91 cwt.

QUICKWORK No. 321 Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity 14 S.W.G. mild steel, depth of shear throat 30in., cuts circles from 6in. to 60in. diameter, weight approximately 18 cwt.

B.E.N. Model TS9 2-Stage Automatic Air Compressor Unit, comprising : 2-stage vee type air cooled compressor, arranged motor drive for 400/440/3/50, motor and compressor mounted on horizontal air receiver, displacement 9 cu. feet per minute, working pressure 200 lb. per sq. inch. Photographs of the above are available.

MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.

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5-ton Aveling Barford diesel Road Roller.
10-ton Butters Hand Derrick Crane, 18ft. fixed radius.
3-ton Taylor Jumbo Hydraulic Crane, diesel-driven.
5-ton Coles diesel-driven self-propelled Mobile Crane on pneumatics.
5-ton Morris Versatile diesel/elec. Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco Crane 4ft. 8½in. gauge, 35ft. jib, new 1949.
6-ton Rapier Super pet./elec. Mobile Crane on solid rubber tyres.
6-ton Rapier Standard pet./elec. Mobile Crane on solid rubber tyres.
¾ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.
¾ cu. yd. Rapier 423 diesel-driven Excavator with shovel or dragline equipment.
1 cu. yd. Rapier 440 diesel-driven Excavator with shovel or dragline equipment.

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E8774 G

FOR DISPOSAL—NEW CENTRIFUGAL PUMPS, by the Pulsometer Engineering Co., Ltd. Bare shafts but, if desired, can be supplied with prime movers.

Type	Suction	Delivery	Max. Head	G.p.m.
HSL8	10in.	8in.	28ft.	2000
FW4	4in.	4in.	100ft.	400
UNISTREAM	3in.	2½in.	160ft.	100
A4	5in.	4in.	73ft.	250
A2½	3in.	2½in.	86ft.	115

CENTRIFUGAL PUMPS, by Worthington-Simpson, Ltd. Bare shafts but, if desired, can be supplied with prime movers. Two unused "CEVAC," self-priming type. Size 2in./3in., 100 g.p.m., 60ft. head. Two reconditioned type L, 8in. suction, 6in. delivery, maximum head 116ft., 1080 g.p.m. One reconditioned type L, 6in. suction, 4in. delivery, maximum head 60ft., 420 g.p.m. One reconditioned type L, 5in. suction 4in. delivery, maximum head 52ft., 430 g.p.m. Full details and prices on application.

Your enquiries invited for PUMPS AND PUMPING SETS—all sizes, duties and types (centrifugal, turbine, diaphragm and reciprocating). Motor, engine or belt-driven.

Stockists of "MONO" pumps for domestic and industrial purposes.

STANLEY ENGINEERING CO.,
TRIANGLE NORTH,
OLDFIELD PARK, BATH.
Telephone : Bath 4294. Established 1910.
Telegrams : "Trius." E8850 G

AUTO SYNCHRONOUS MOTOR by Crompton Parkinson, 220 h.p. 500 revs 3/50/400 volts with exciter, main contactor, liquid starter and exciter regulator.—THOMAS MITCHELL & SONS, LTD., BOLTON. E8700 G

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FRED WATKINS
(ENGINEERING), LTD.

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p. ; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Broomwade 400, 300, 200 and 130 cu. ft. ; all motorised ; Reavell Rotary Blowers, 2000 c.f.m., 3–2 p.s.i.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.

CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib ; 6-ton and 4-ton Coles Diesel-Electric ; 3-ton Jones Super 40 (3) ; Neals 2-ton Diesel, 20ft. jibs (2) ; Derrick, 10-ton Henderson Steam, 120ft. jib ; 5-ton Wilson Electric, 70ft. jib ; Steam Loco, 18-ton Brownhoist, 50ft. jib ; 10-ton Coles, 40ft. jib ; 8-ton Wilson, 35ft. jib ; 5-ton Smith, 50ft. jib ; 5-ton Cowans Sheldon, 50ft. jib ; 5-ton Grafton, 38ft. jib ; E.O.T. 40-ton Adamson, 42ft. span ; 20-ton Vaughan, 42ft. span (8) ; Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris ; 5-ton Henderson, 24ft. 7½in. span, 1946 ; 5-ton King, 29ft. 3in. span ; 2-ton Morris, 18ft. span ; 2-ton Smith, 34ft. span.

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		Main Location	*Auctioneers*
October 21–24	**Machine tools, vehicles and miscellaneous stores.**	M.O.S. Storage Depot, Royal Arsenal, **Woolwich, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL** (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
October 29–30	**Miscellaneous stores,** including:—	Northern Command Ordnance Sub Depot, **Barlow, Near Selby, Yorkshire.**	**BARTLE & SONS** (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)

Canvas, blankets, tentage, webbing, haversacks, trousers, greatcoats and other clothing; old batteries, cable and tyres; tools and tool kits, gravity roller conveyors, weighing machines, shelters, steel racking and shelving, surveying equipment; electrical wireless and telephone equipment; pneumatic concrete breakers, picks, drills, etc.; Mack, Morris, Thorneycroft and other engines, gearboxes, M.T. spares, etc.; hutting parts, furniture and other miscellaneous stores.

November 5–6	**Machine tools and miscellaneous stores.**	Technical Stores Depot, Old Dalby, **Melton Mowbray, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
November 12	**Miscellaneous stores.**	15 C.E.S.D., Arncott, **Bicester, Oxon.**	**MIDLAND MARTS, LTD.** (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
November 17–21	**Vehicles, lifting and earth moving equipment, ancillaries and spares for civil engineering plant.**	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)

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(b) for Tender Forms should be made to the Ministry of Supply, Directorate of Disposals, First Avenue House, High Holborn, London, W.C.1.

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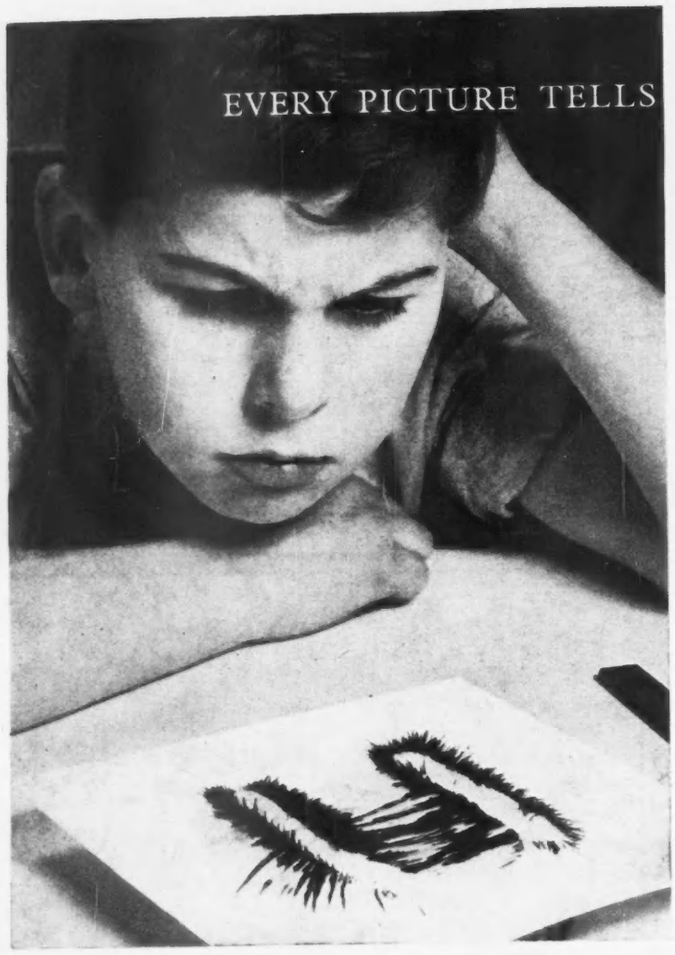

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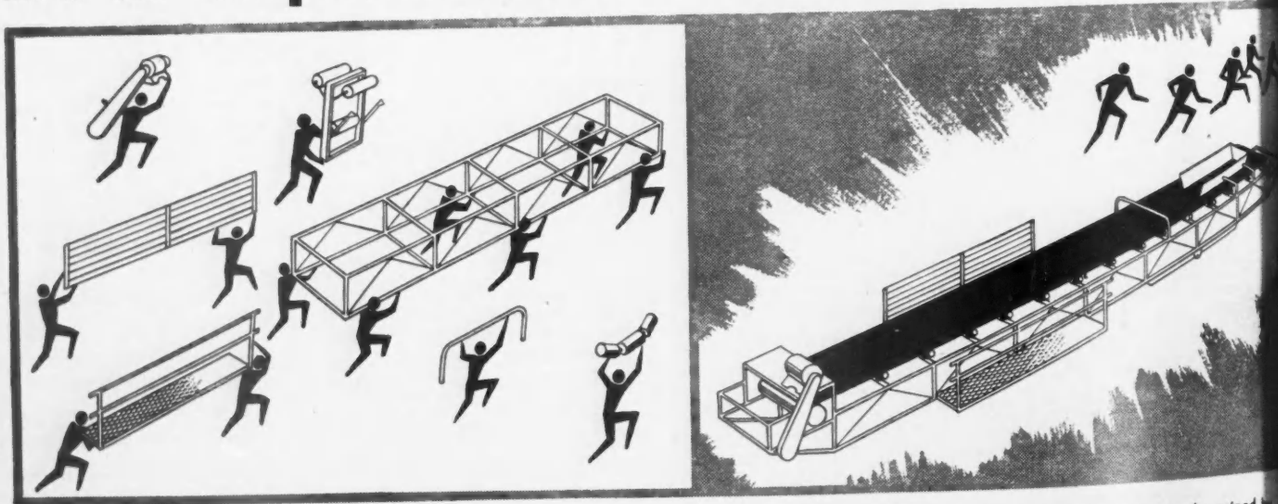

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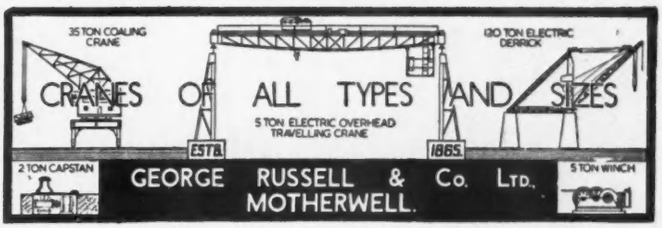

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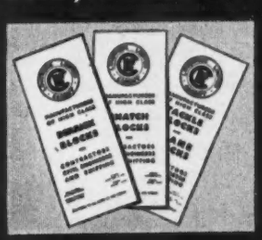

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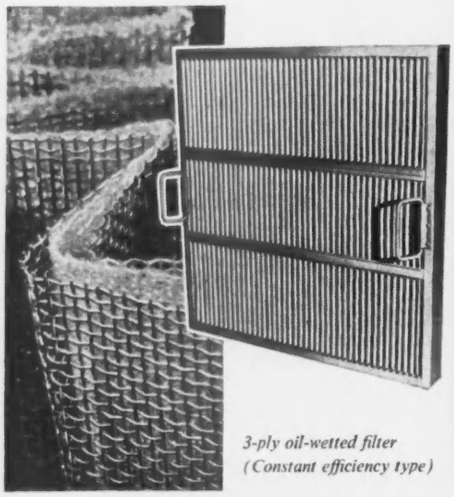
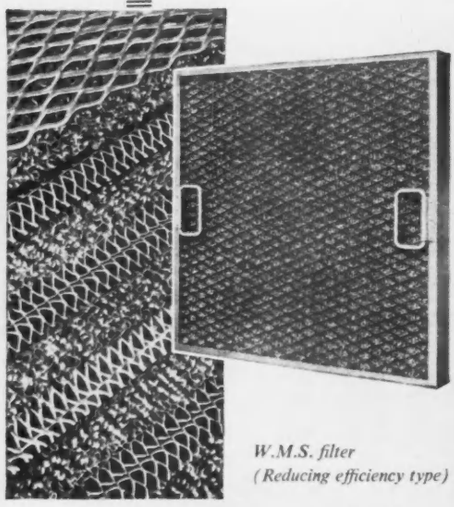
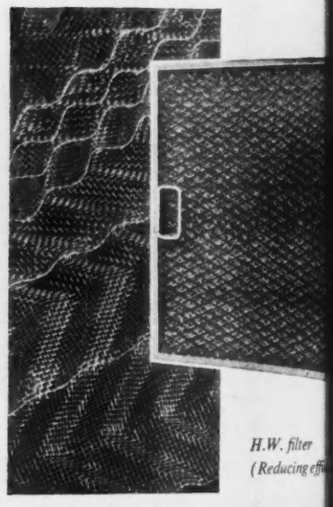


3-ply oil-wetted filter (Constant efficiency type)



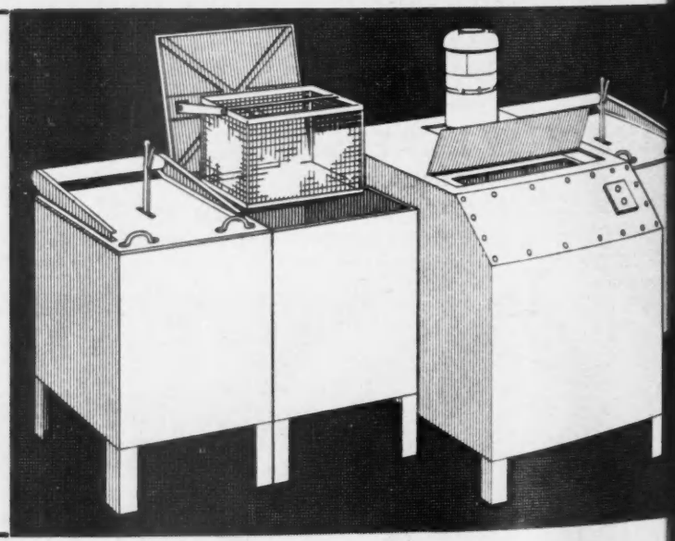
W.M.S. filter (Reducing efficiency type)



H.W. filter (Reducing effi

CLEANING AND OILING PLANT FOR VISCOUS PANEL FILTERS

This special plant has been designed to assist users in maintaining filters with a minimum of cost and labour. To cater for both large or moderate numbers of filters the plant is available in units with optional fittings. The unit consists of 3 tanks—a cold solvent tank, a hot rinse tank, and a centrifuge tank. Soundly constructed of heavy gauge mild steel, all internal surfaces are coated with aluminium and resistant lacquers. The Vokes Cleaning and Oiling Plant is already in use by British Railways. Full technical details and drawings are available on request.



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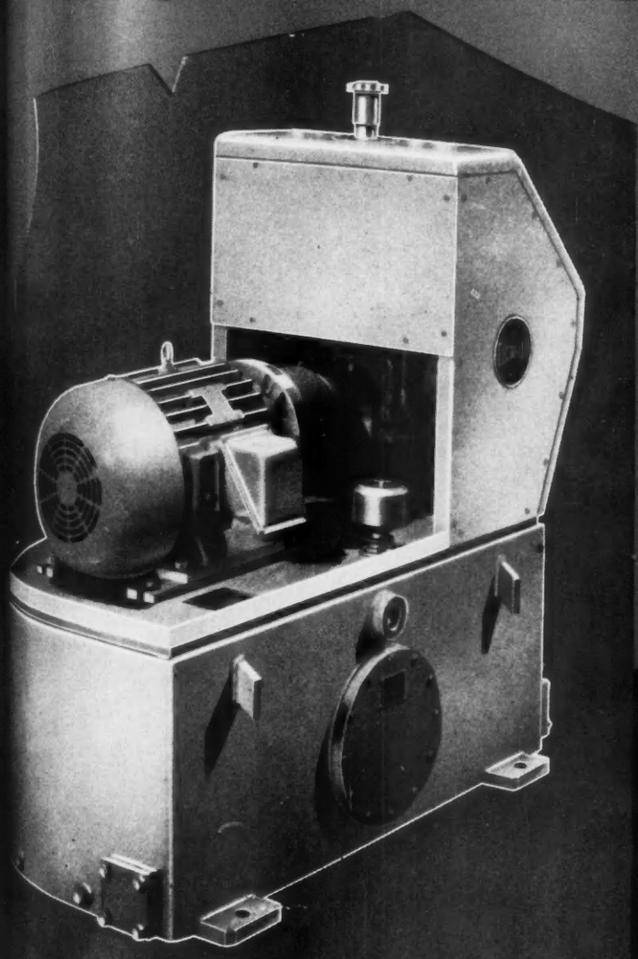
ff the peg but tailor made

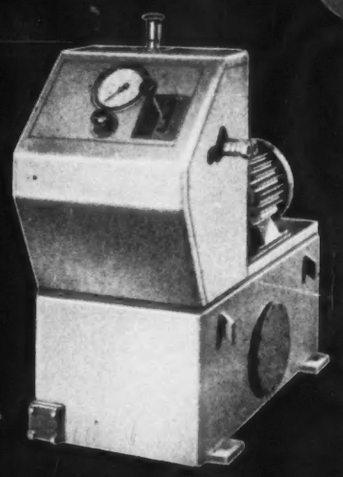


You can buy very good clothes off the peg (they are still tailor made) and it saves waiting. For non-stock sizes when alterations have to be made the suit still comes cheaper and delivery is quicker.

Now, Towler Brothers have adopted the same principle for a range of packaged pump units. They can be delivered in stock sizes quickly, or adapted for special purposes. Taking British standard frame size electric motors and any one of the range of axial plunger pumps, a wide range of pressures and deliveries become available. It is only necessary to wire to the motor starter, already on the unit, couple up pressure and return pipes to the cylinder to be powered—and production can start.

Standard units are arranged for automatic pump unloading and pressure sustaining. Directional and pressure variation controls, pressure gauge with isolating cock, oil sight glass and air filter are all incorporated on the 50 gallon tank unit. A control to give infinitely variable delivery can be fitted.

Please write or telephone for literature.



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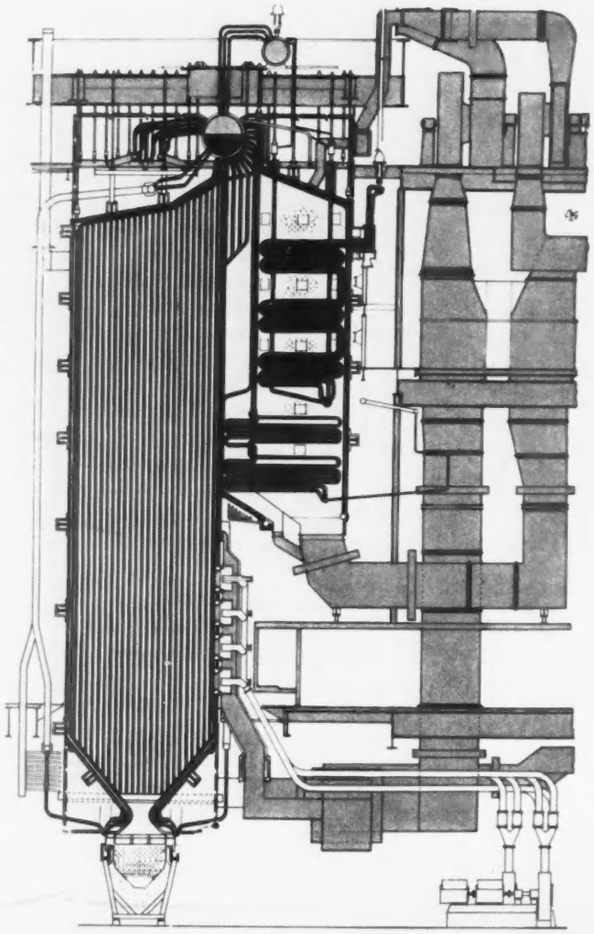
OCTOBER 17, 1958

JOHN THOMPSON "ETAFLO" WATER TUBE BOILERS

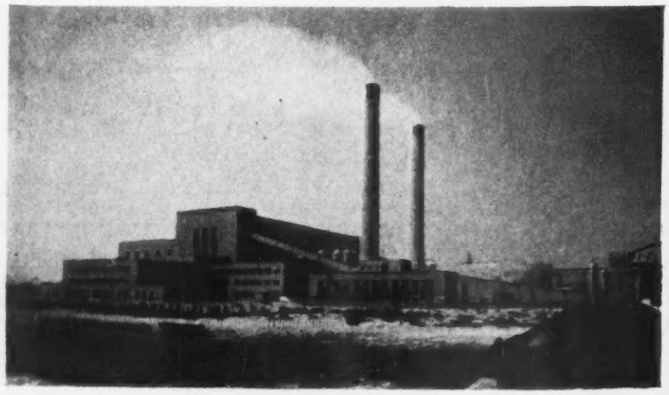


Combining the many advantages of forced and controlled circulation with the operational simplicity of the natural circulation boiler, the " Etaflo" boiler has proved to be most successful.

In Britain and in many parts of the World, John Thompson "Etaflo" boilers are providing steam power and superlative service. The most up to date generating stations are taking advantage of the many patented features of the John Thompson "Etaflo" boiler; Marchwood, Tilbury and Bold "B" being among their number.

"Etaflo" boilers work at high temperatures and pressures and a large steam output. The boilers at Marchwood for example have a working pressure of 925 p.s.i. with a final steam temperature of 915°F. The evaporation rating of these boilers is 550,000 lb/hr.

The diagram opposite shows a simplified layout of a typical "Etaflo" boiler.



The colour photograph is of the 360 MW. TILBURY GENERATING STATION equipped with six pulverised fuel "Etaflo" boilers arranged for alternative oil firing, with an evaporation rating of 540,000 lb/hr.

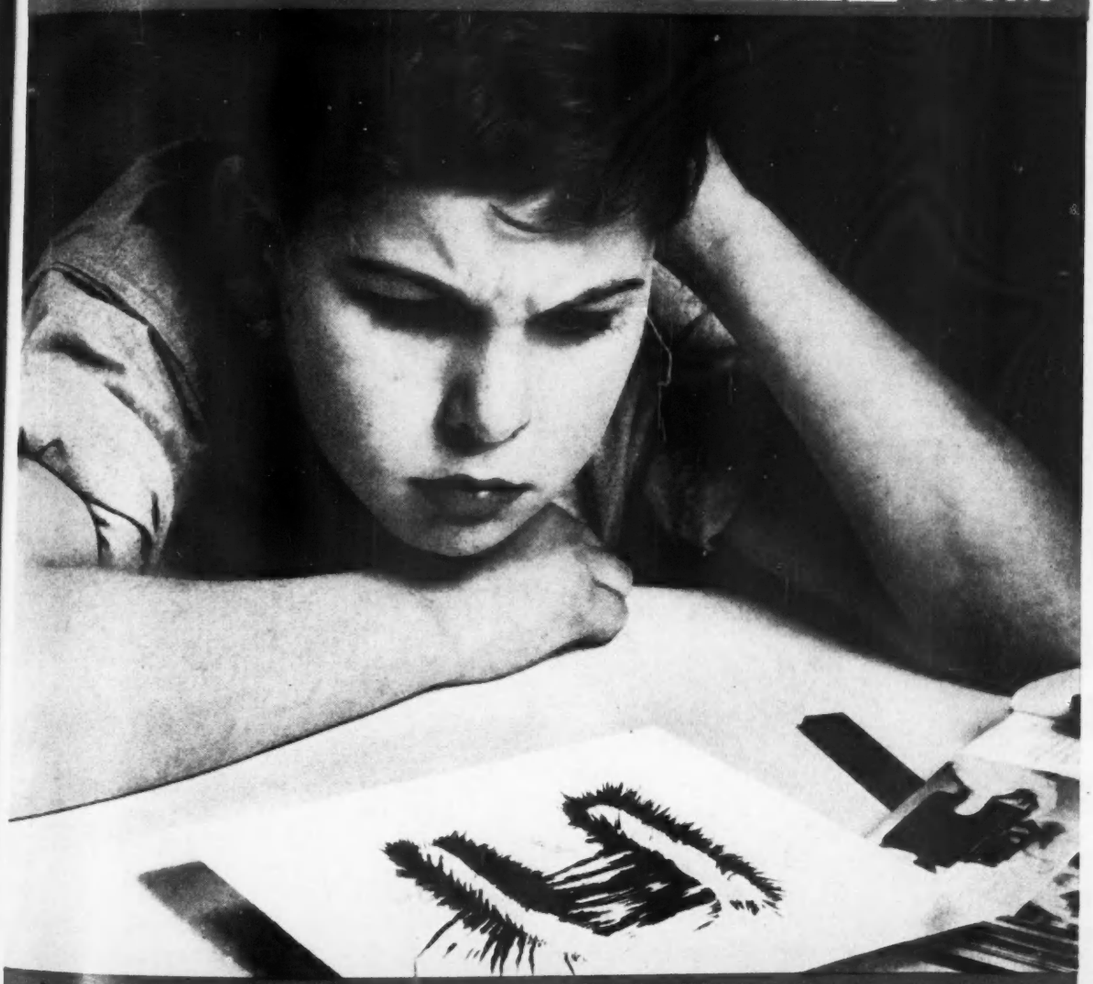
JOHN THOMPSON WATER TUBE BOILERS LIMITED · WOLVERHAMPTON

WTB/6

The Engineer

OCTOBER 24, 1958 28 ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS

EVERY PICTURE TELLS A **NICKEL** STORY



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